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THE
ATTACK AND DEFENCE
OF
COAST-FORTIFICATIONS.

BY

CAPT. EDWARD MAGUIRE,
CORPS OF ENGINEERS, U.S.A.

NEW YORK:
D. VAN NOSTRAND, PUBLISHER,
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1884.

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INTRODUCTION.

It is almost universally conceded that to-day, as in the past, fortifications play the most important *rôle* in the defence of coasts and harbors. In the United States, submarine mines and other obstructions are officially regarded as auxiliaries only, although very important and powerful ones. It is also generally conceded that the defence of our coasts cannot be purely a naval one, but that our reliance must be mainly on coast-fortifications.

The rational use of coast-artillery, and the development of a correct system of defence, are based upon a knowledge of the means of defence, of the capability of those means, and of the method of employing them. They are also based on a knowledge of the hostile means of attack, and of their greater or less fitness for the work assigned to them.

As a rule, the periodical military literature, as well as the text-books, treat the above-mentioned subjects only by piecemeal, and usually only with reference to some particular work which the author, at the time, has on hand. Under such circumstances, one is forced to wade through a great mass of material in order to garner that which is worth knowing. This is a tedious, and often impracticable process. Books are expensive, professional libraries scarce; and a knowledge of

French and German, at least, is almost indispensable to the student.

Again: a great many of the text-books go too much into the details of old forms, and devote too much attention to dead issues. The tendency is to force the young man to spend part of his life in a past age; that is, to encumber his mind with a mass of information which even his grandsire would have been glad to have forgotten.

To supply a want which it is believed exists, the following pages are offered, particularly to the younger generation. The subject-matter lays no claims to originality; being compiled from various sources, and largely from an article by Capt. Carl Křiwanek of the Austrian army, entitled "Der Angriff auf Küstenbefestigungen und die Vertheidigung derselben." The work is intended simply as a labor-saving machine, and as such it is hoped it will be successful.

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THE ATTACK AND DEFENCE
OF
COAST-FORTIFICATIONS.

CHAPTER I.

NAVAL FIGHTING-MEANS.

EVERY large navy is made up of men-of-war (armored ships), coast-defenders, cruisers, despatch-boats, transports, school-ships, and various vessels for harbor service.

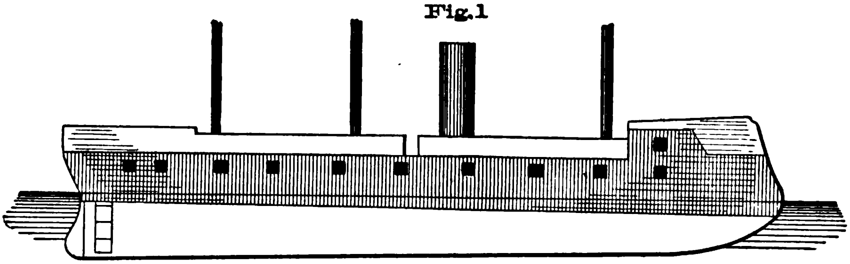
In latter days, torpedoes have been introduced, as well for naval battles as also to play a positive *rôle* in the defence of coasts and harbors. For operating them, either special torpedo-boats are used, or the war-ships themselves are provided with the special apparatus necessary for that work.

The duty of war-ships is to seek out the enemy, and join battle on the high-sea: accordingly, they should have a numerous armament of heavy calibers, as well as a strong armor, of such a nature that they can give battle under all circumstances: they should, moreover, be so equipped that they can for some time remain independent of home supplies and workshops. They have a comparatively high free-board; that is, a large portion of the hull is out of water, exposed to the enemy's shot. They have the stability due to a considerable draught (twenty-four to twenty-eight feet), and are generally provided with sails, in order to make use of the wind in case the engines, from any cause, fail to work, and also to save coal on long cruises.

Men-of-war are divided into "broadside" and "turret ships." To the first class belong the "battery" and "casemate ships."

Battery-ships are the oldest of the sea-going armored ships, and constitute the connecting link between the modern vessels and those built before the epoch of armor. The earlier customary arrangement of the guns — on both sides of the ship, from stem to stern — is retained, and the battery is armored for its whole length (Fig. 1, Austrian "Ferdinand Max"); or the armament, and with it the armor, is omitted or diminished at each end of the vessel. (Fig. 2, German "König Wilhelm.")

Fig. 1



Since each ship can carry only a limited weight, the battery-ship has the disadvantage that its armor, in consequence of its great extent, cannot be made sufficiently strong without the vessel becoming excessively large, and consequently very costly.

For that reason, casemate-ships (Fig. 3, "Erzherzog Albrecht") were gradually developed. In the latter, instead of an extended battery, the guns are placed in the so-called "casemate," — a comparatively small armored space in the middle of the ship. With the reduction in the battery

Fig.3

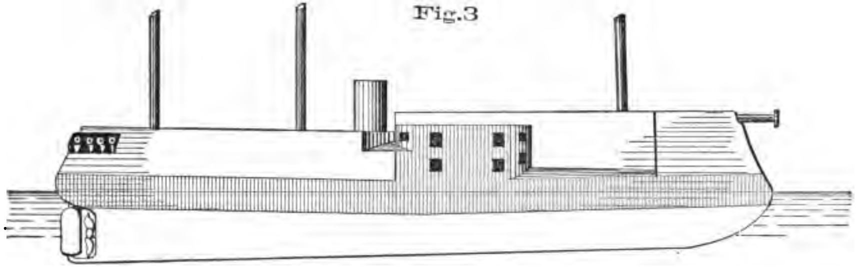
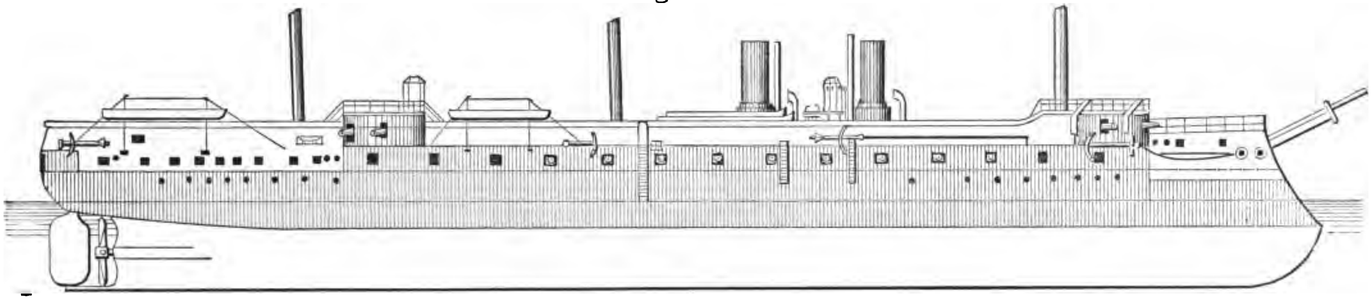


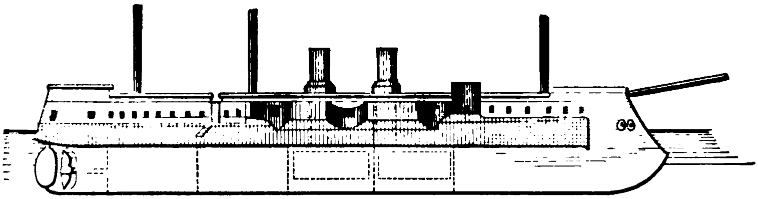
Fig.2



space, the number of the guns had to be diminished; and this was compensated for by mounting guns of larger caliber and greater power. Since in these ships, throwing out of consideration the armored belt, the area of armor is small, the latter is made much heavier.

In order to gain a fore-and-aft fire from covered positions, various kinds of arrangements have been resorted to in casemate-ships.

Fig. 4.



The "bow-chasing-guns" are, on the older casemate-ships, mounted on the upper deck, either behind armored shields which extend from the armored belt up above the upper deck, or behind shields which stand on the deck, and are not connected with the armored belt, or without armored protection. The "stern-chasers" are mounted on the upper deck, either behind shields, or without armored protection.

On some ships of this class, portholes are cut close to the sides of the vessel, in the ends of the casemate; and the ship's sides are there carried obliquely inwards, or "tumbled-home," in order to enable the end guns to fire as nearly as possible in the direction of the keel. In other ships of this class, the bow and stern guns are mounted in an armored out-building situated over the battery, and projecting somewhat over the sides of the vessels, or in fixed half-turrets similarly situated; and, in order that these guns may fire in the direction of the keel, the sides are carried inwards. In the most recent casemate-ships, the fore-and-aft fire is attained through a special arrangement, the projections, of the casement itself. (Figs. 4 to 6, Austrian "Tegetthoff.")

Fig. 5

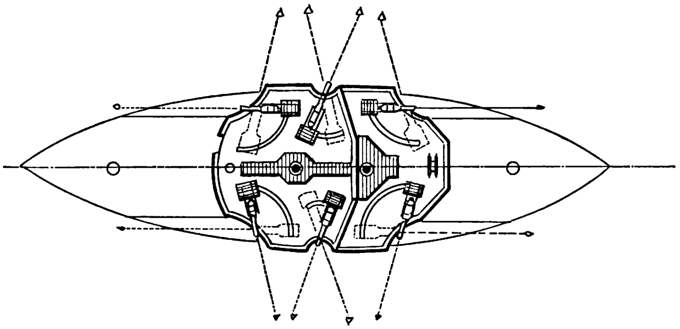
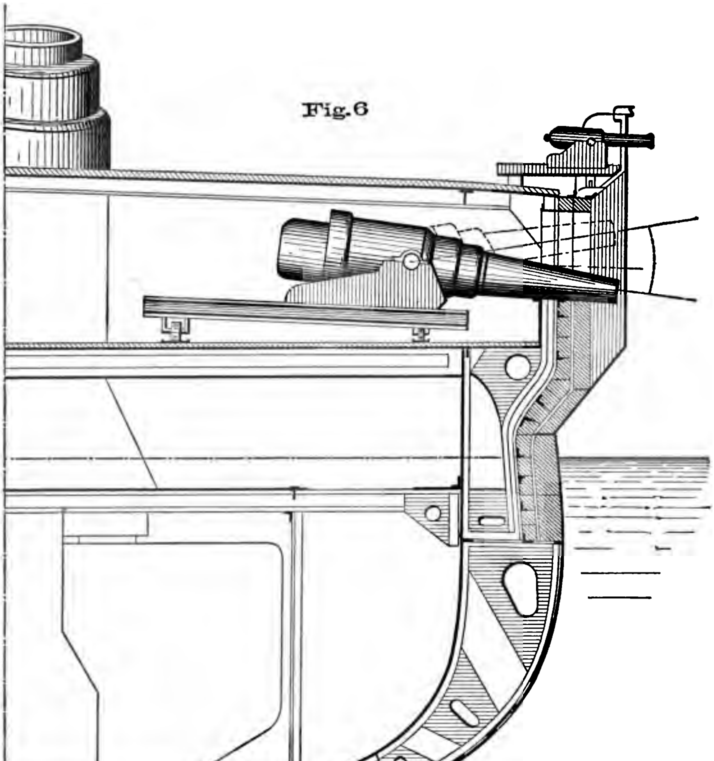


Fig. 6



In turret-ships (Figs. 7 and 8), the guns are mounted in low, cylindrical iron turrets, which are situated in the midship-line. The area of armored gun-cover is reduced to a minimum, and the armor is therefore very heavy. The turrets are either stationary (fixed turrets), — the guns being mounted on revolving platforms, and firing *en barbette*, — or they revolve (revolving turrets); in which case the guns turn with them. Breech-loading guns are provided with carriages of such a form that they can fire through portholes of minimum dimensions: the muzzle-loading guns are generally not so provided.

Fig.7

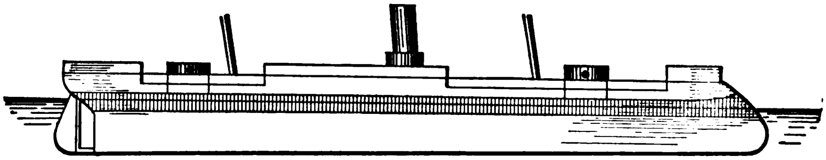


Fig.8

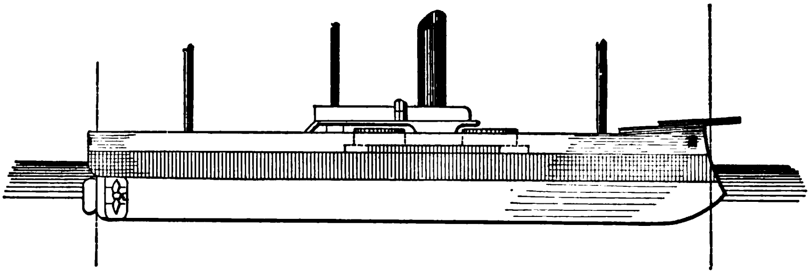
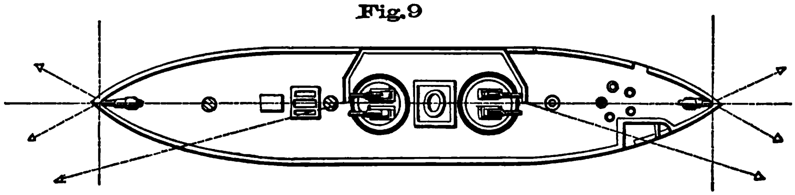


Fig.9

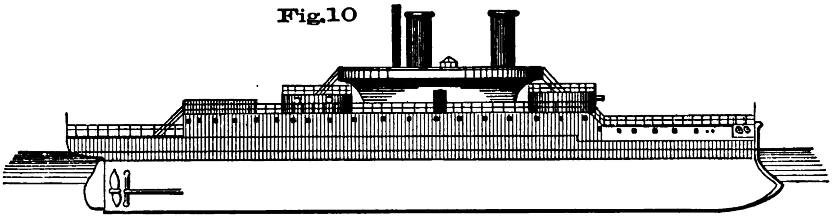


Fixed turrets are but slightly vulnerable; but the guns, however, are protected only in their lower parts.

In revolving turrets, the turning mechanism is easily damaged by a hostile shot, or by heavy rolling and pitching in a storm, etc. Therefore, in order to shelter the mechanism from the enemy's fire, the turret with its base is carried down to the armored belt (Fig. 7, Italian "Affondatore"), or the armor amidships — opposite the turret — is carried up; so that the turret really stands in a casemate. (Figs. 8 and 9, "Preussen.")

In the so-called breastwork-turret ships, the turrets stand in a double-oval turret, the "breastwork." The guns of the inner turrets fire through portholes; those of the outer ones, *en barbette.* (Fig. 10, English "Devastation.")

Fig. 10



The most recent turret-ships have no longer a complete armored belt at the water-line, but are now armored for only about one-third of the ship's length. (Figs. 11 and 12, Italian "Duilio.") The side armor is carried up above the upper deck, and forms a closed, all-around-armored species of citadel, in which the turrets stand on a line diagonal to the midship-line. The absence of armor at the end of these ships is compensated for by an armored deck (horizontal armor) located below the water-line. Ships of this class are also called "citadel ships."

A new type of turret-ships is represented by the barbette-turret ship, which is also only partially protected by armor. (Figs. 13, "Collingwood," and 14, "L'Indomptable.") In these ships the guns are mounted on revolving platforms in fixed turrets, open overhead, and fire, therefore, over the upper edge of the armor. The turret-walls are inclined inwards at an angle of 60°, and consist throughout of flat (not bent) plates; and consequently angles are formed at the junctions.

The barbette-turrets permit the mounting of very long, powerful guns, are much lighter than the closed revolving turrets, and allow of firing with the greatest elevations. Furthermore, the guns in these turrets are mounted higher, which, according to the experience at Alexandria, — where the guns of the "Inflexible," on account of their low positions, could not take their desired share in the bombardment of the forts, — is of importance.

Fig. 11

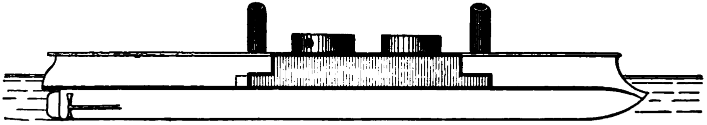
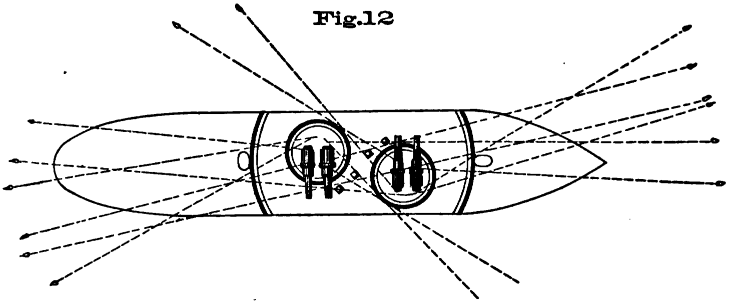


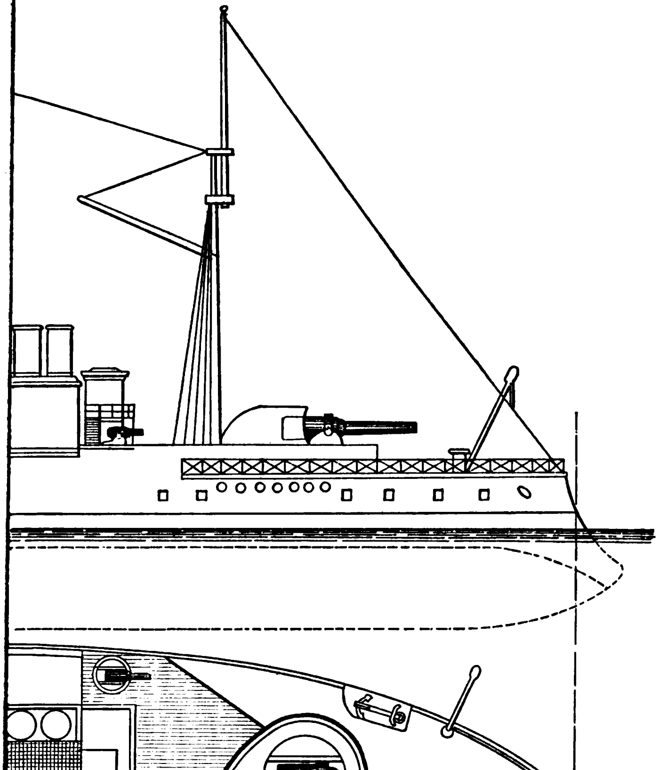
Fig. 12



In the barbette-turret in Fig. 14, the guns are protected above and behind the platform by a half-cupola made of steel.

While the older broadside-ships are armed with twenty and more guns, the battery and casemate ships have mostly only six to eight, but, however, very powerful (twenty-six and twenty-eight centimetre) guns.

The armament of the turret-ships consists, ordinarily,



of four of the most powerful guns, such as the 100-ton Armstrong, the 81-ton Woolwich, the 30.5 to 40 centimetre Krupp.

The portholes of the battery and casemate ships are placed at nearly half the height of the ship out of water;

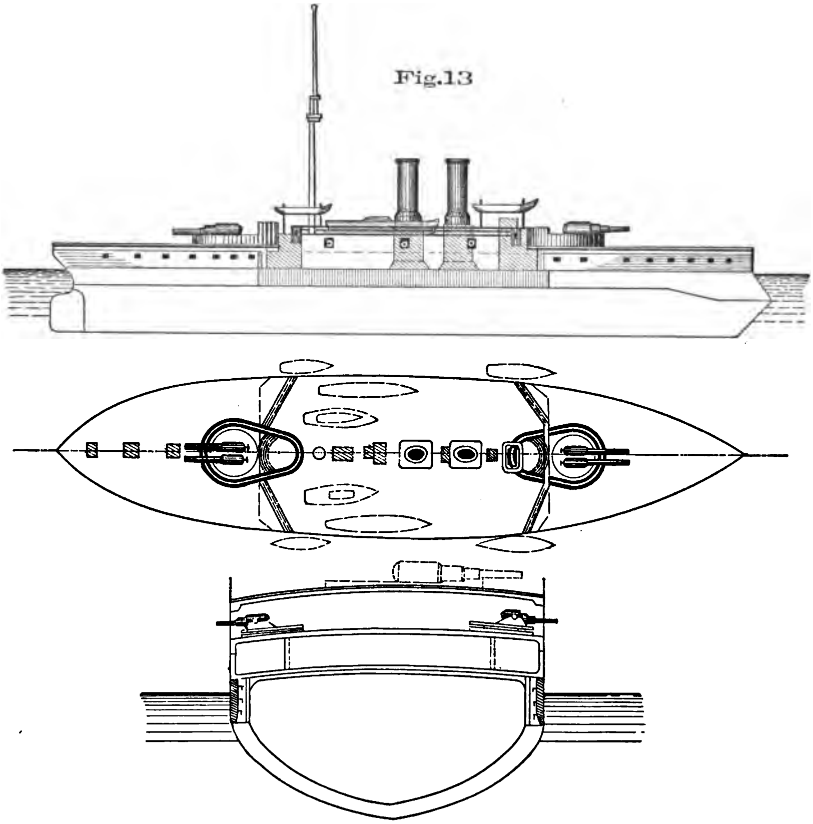


Fig.13

in the turret-ships, somewhat over half, if we consider the turret as a continuation of the ship's armor.

With the exception of those of the oldest types, warships are provided with an armored belt which extends five to six and a half feet below and above the water-line.

It is strongest amidships, being four and a half to twenty-four inches thick, according to the construction. The ends of the ship are less heavily armored, since at these places the effect of the shot is diminished on account of the curvature of the plates.

In the older ships, the deck has an armor of a quarter of an inch thickness. In the later ones, it is heavily armored to over three inches thickness.

In order to render harmless the leaks made by the enemy's shot, the hull is divided into water-tight cells by means of bulkheads.

Coast-Defenders. — In order to present but a small mark to the enemy, these vessels have but little freeboard: they have a light draught, and can consequently escape from the enemy by retreating into shallow water. Since they do not have to move far from the shore, they have no sails. Some are armored, others not. To the first class belong floating batteries, monitors, armored gunboats, and circular ships (Popoffs). To the second class belong the unarmored gunboats, or floating gun-platforms.

Floating Batteries. — These are vessels with but little capacity for manœuvring, and intended to fight only with their guns: they therefore have but weak engines, or none at all. In the latter case they are towed to the scene of action, and anchored there. They are consequently the counterparts of the interval batteries so important in the defence of land-fortifications.

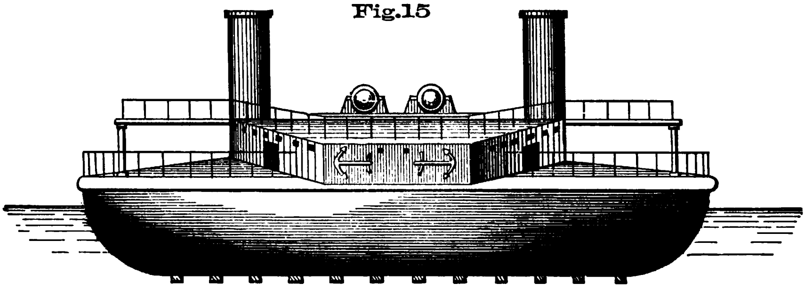
Monitors. — These vessels, invented by the Swede Ericsson, and named after the first of their kind, lie so deep in the water that only a very small portion of the hull (in the case of river-monitors, often only a few inches) is out of water. On the deck stand one or two turrets, in which the guns are mounted. The turrets are fixed, or turn on a vertical axis. Sometimes there is in addition a small armored turret ("conning turret"), which is intended for the commander and the pilot-wheel. Air for the crew and engines is supplied artificially, since the hatches cannot be kept open at sea.

Armored Gunboats. — These are small vessels, with only one gun of large caliber, which is protected by a fixed semi-cylindrical shield, or the like.

Circular Ships. — These vessels, called "Popoffs," after the Russian Vice-Admiral Popoff, the constructor of the first vessel of the kind, are shown in Fig. 15. In the middle of the ship stands a fixed turret, with two very heavy guns firing *en barbette* from revolving platforms. On account of the great number of their screws, these vessels may be turned very quickly; but they have not a rapid speed ahead.

Unarmored Gunboats. — These are small boats of light draught, which carry only one gun of heavy caliber. The latter, mounted on a rising and lowering platform, usually lies in the hull, and is raised by machinery to the necessary height above deck only to fire.

Fig. 15



Cruisers. — To this class of ships, whose duty it is to protect their own merchant-marine, and prevent that of the enemy from going to sea, belong the unarmored frigates and corvettes, — decked and undecked, or flush-deck, corvettes.

Torpedo-Boats. — These are small boats arranged for launching torpedoes, — mostly Whitehead. In order that the torpedo may strike, and be effective, it should be carried quite close to the object of attack before being launched; and hence torpedo attacks must be made as rapidly as possible. Therefore the torpedo-boats are given a great rate of speed (eighteen to twenty knots), and are provided with noiseless engines, which generate but little smoke. They are generally built of steel, and are of light draught.

CHAPTER II.

OPERATIONS OF A FLEET AGAINST COAST-FORTIFICATIONS.

THE operations of a fleet against coast-fortifications consist of the blockade, the bombardment, and the attack by sea.

The Blockade.—Blockading (corresponding to the investment of land-fortifications) is resorted to chiefly with the object of breaking up or injuring the commerce and transmarine trade of the enemy. Its special object is to shut up the enemy's fleet, or a portion of it, in a harbor, in order to prevent it from undertaking operations abroad; or it may be established in order to complete the investment of coast-fortifications attacked by land.

As a rule, the blockading fleet does not allow itself to be drawn into conflict with the coast-fortifications, unless with the view of dislodging a portion of the enemy's fleet from advanced positions. To accomplish this, it may be necessary to first silence the coast-works serving as a cover for those positions. Otherwise, the blockading fleet keeps beyond range of the coast-guns, and establishes a strong guard in order to keep advised of the movements of the enemy, and of any fleet which might come to his relief. The ships are constantly kept ready for action, and with steam up, in order to anticipate any hostile counter-operations. If the defence, in addition to *sorties* of its own fleet, should endeavor to operate with offensive torpedoes, then the blockading ships should protect themselves with nets stretched on spars outside of, and at sufficient distance from, the hull. Their machine-guns should at all times be ready for use. For torpedo attacks, the enemy will generally select the night: the blockading ships should therefore change their positions as soon as darkness sets in, and also, in order to deceive the enemy, establish false-position lights attached to floats, etc. The fleet should, moreover, preserve its communications with its own country, in order to keep provided with the necessaries of life, and munitions of war.

In blockading a fort attacked by land, the fleet must keep up communications with the besieging army by means of a system of signal-stations, safe anchoring-grounds near the shore, and by landing-places at suitable points, which are, by their location, and distance from the enemy's works, secure against the fire of the forts, or capture by *sorties*. If the besieging army is rationed by the fleet, or if the siege-material is transported by the fleet, then the landing-places naturally possess a great importance, and fortifications should be erected for their protection.

The Bombardment. — The object of the bombardment is the destruction of the enemy's military and marine establishments, of the ships lying in the harbor, of the magazines, etc. An effective prosecution of the bombardment necessitates a somewhat accurate knowledge of the location of the objects to be destroyed, and of the means of defence at the disposal of the enemy. As the data of this nature collected in time of peace are not sufficient, reconnaissances should be made, during which the ships approach rather close to the coast-works in order to draw their fire. The reconnaissances are made at night, and with the electric light, by armored ships, or smaller vessels or boats, according to the nature of the channel.

In conducting a reconnaissance in force, the ships should move directly on the objects, instead of defiling by them.

They should always keep in motion, since it is of more importance for them to lessen the danger of the hostile fire than to attain any result with their own.

In order to produce any lasting effects by the bombardment, the fire of the ships should be carried on systematically. Each ship should be given a position, based on the reconnaissance and the plan of attack adopted; and the object at which it is to fire should be made known to it. The ships ordinarily keep in motion at the positions assigned to them, and generally there are laid out for them certain zones of manœuvre, within which they have to keep up the fire.

The casemate and turret ships can keep up the fire while running end on; but the broadside-ships should manœuvre, so that, before delivering fire, their course may be nearly normal to the plane of fire.

The bombardment may be carried on at ranges of 4,000 to 6,500 yards, depending upon the effective ranges of the naval guns, whose limit of elevation is about 15°.

In the Chili-Peruvian War, on the 26th of February, 1880, and during the six days following, Arica was bombarded by the Chilian wooden vessel "Angamos," with one 12-ton gun, at a range of 5,500 to 7,300 metres. The 18 Vavasseur, Parrott, and Rodman guns, as well as the guns of two other coast-batteries, could not injure the ship, since it kept out of effective range of these guns. The "Angamos" and "Pilcomayo," re-enforced by the armored ship "Huascar," on April 22, 1880, bombarded Callao, at ranges of 5,000 and 6,500 metres. Re-enforced by three other vessels, the bombardment was continued on May 10. While the armored "Huascar" kept off only between 2,000 and 5,000 metres, the other vessels bombarded at ranges of 4,000 to 7,000 metres. With an expenditure of 300 rounds of ammunition, those vessels seriously damaged three of the Peruvian ships anchored in the harbor of Callao.

At Alexandria the stations of the ships were as follows: —

"(First phase, 7 A.M. to 10.30.) The 'Alexandra,' the 'Superb,' and the 'Sultan' engaged the forts and batteries from Ras-el-tin to Pharos.

"These ships were under way until about 9.30, and up to that time engaged at a range of from 1,500 to 2,400 yards. They then anchored at a range of from 2,200 to 3,550 yards.

"The 'Inflexible,' stationary, but not anchored, engaged Fort Ras-el-tin (at 2,700 yards) and Oom-el-Kubeba (at 4,000 yards).

"The 'Invincible' and the 'Penelope,' at anchor at a range of 1,500 yards.

"The 'Temeraire,' at anchor at a range of 4,000 yards, supported the 'Invincible' and the 'Penelope.'"

The "Inflexible" is a citadel-ship with two turrets, each having two 80-ton guns. The maximum thickness of armor is 24 inches.

The "Temeraire" carries four 25-ton guns, two on the upper deck, and two on the battery on the main deck; four 18-ton guns, for broadside fire only. The maximum thickness of armor on the belt is 11 inches; and on the batteries the thickness is 10 and 8 inches.

The "Alexandra" carries two 25-ton guns, and ten 18-ton guns. The maximum thickness of armor on the belt is 12 inches, and the thickness on the batteries is 8 and 6 inches.

The "Sultan" carries eight 18-ton guns on the lower deck, two 12-ton guns in the upper-deck casemate, and two of the same weight on the upper deck forward. The greatest thickness of armor is 10½ inches.

The "Superb" carries sixteen 18-ton guns, and a few lighter pieces. The greatest thickness of armor is 13½ inches.

The "Invincible" carries ten 12-ton guns, and four 64-pounders, and the greatest thickness of armor is 9¼ inches.

The "Penelope" carries eight 9-ton guns, and three 40-pound Armstrongs, and the greatest thickness of armor is six inches.

The maximum range of naval guns, if they fire through portholes, is dependent upon their command as well as the construction of their carriages. The range may be considerably increased by the "heeling" of the vessel to the side opposite the direction of its fire. In the new iron ships, with double bottoms and cellular compartments, "heeling" may be produced by pumping water into the cells on the side towards which the vessel is to list. In ships of older construction, it is produced by shifting the ballast.

Some authors contend that bombardments should be carried on at ranges of 8,000 to 10,000 yards, and that heavy guns should be mounted on the decks of the ships in order that they may be fired under elevations up to 30°.

This is already accomplished in the breastwork and barbette-turret ships, and by the heavy bow and stern guns.

The greater the range at which the bombardment is carried on, the greater may be the speed of the ships during the firing.

To actually carry on a bombardment at the great ranges mentioned above may possibly give rise to many considerations; but, in making our calculations, we must consider those ranges as at least possible.

Ships will undoubtedly carry on a bombardment of fortified war-harbors at the utmost attainable range of their guns, since a real attack can be carried out only with great difficulty, and hence will seldom be undertaken.

The opinion of many authorities in regard to bombardments is well set forth by De Luca, who says, —

"Should a fleet wish to destroy at long ranges well constructed and protected coast-fortifications, it is clear, that, in spite of its powerful artillery, it only wastes its time and ammunition; and if at short ranges, where its armor can be pierced by the coast-artillery, it pushes its ships only into useless difficulties. In consequence of the nature of the task itself, therefore, the fleet cannot attempt to destroy the works of the coast-fortifications as by a siege on land; but it can try to destroy only those objects for the protection of which the fortifications are intended.

"The object to be attained by a fleet is the destruction of the enemy's arsenals, ships, magazines, etc., and not of the batteries intended for their protection.

"The fleet has generally to perform the duty of carrying on its work of destruction under the fire of the batteries without replying to it."

Attack by Sea. — While we may assume the bombardment as the attack most frequently to be expected, yet it may well happen, that for forced reasons, or because it deems itself sufficiently powerful, the fleet may plan and execute a real attack, — an "attack by sea."

This attack by sea may be compared to a land siege. The fleet will first bombard the sea-forts at long range, in order to silence their fire; thereupon, it will approach nearer to the coast forts and batteries, in order to carry on with favorable chances the decisive fight intended for the complete subjection of the latter. Finally, it will turn its attention to those works, mostly more retired, which bear upon the harbor-entrance and its obstructions. This last act may be considered as entirely identical with the heavy and rapid fire of the siege-batteries, which precedes the advance of the storming-party. In case the obstructions consist of submarine mines, and the fleet must destroy them by torpedoes, this operation is identical with the counter-mining operations of a siege. Finally, as the storming of the breach is the crowning act of a siege, so must, or should, at least, the forcing of the harbor-entrance be regarded as the last stage of the attack.

This comparison leads us to the conclusion that the general principles of sieges may be applied also to attacks by sea. In place of the ground in front of the works to be attacked, lies the sea, which with its depths and shoals, rocks, islands, wide and narrow channels, represents the more or less favorable field of operations of the attacking party; while the powerful ships, in consequence of their armor, are very strong batteries, which, after being once completely equipped, need no subsequent aid, and in consequence of their engines can constantly and rapidly change their positions.

The ammunition-supply of the ships will limit their action against a sea-fort to the duration of a few days; and this, in connection with their great mobility, will give to the attack the characteristics of a short, rapid engagement.

The open coast-batteries may be bombarded at long ranges with the lighter guns, in order to render the interior of the forts dangerous, to impair the activity of the guns, and to force them to cease firing. This work may be performed by the smaller ships, which, in consequence of their insufficiency of armor-protection, dare not approach near to the works. The large, armored ships, with their powerful guns, engage the works at the shortest possible range, and by a well-directed fire attempt to destroy most especially the embrasures. Against armored forts, a concentrated fire should be directed. The space necessary for manœuvring a ship forbids the approach to a battery nearer than seven hundred to eight hundred yards.

The landing troops attempt to carry by storm the works assigned to them for attack.

In order to be able to remove the obstructions and submarine mines, the batteries and guard-ships flanking them should be silenced and captured. Should this not be possible, then the observation, firing, and light stations should be destroyed, and then the mine-lines should be cautiously approached at night, and the cables cut. Contact-mines, which are dangerous to remove, should be destroyed by counter-mines. The "submarine detector" should be used. This latter instrument (McEvoy's patent) is constructed on the principle of the induction balance, and consists of an instrument box, small battery, and the detector with its cable and box. The action of the instrument is as follows: "The circuit being closed, and the telephone placed to the ear, a very distinct and regular increase of a humming sound will be heard on the near approach of the detector to any piece of metal, however small, culminating on actual contact therewith."

Another method of searching for and removing submarine mines is the use of submarine boats, which will be referred to in connection with torpedoes.

If the fleet has not these means at its disposal, or if their use be not attended by the desired result, and it be necessary for the attainment of some important military object that the lines must be forced at all hazards, then there remains as the last resort the sacrifice of one or more ships, which clear the way for the others. In such a case, the body of the fleet, united, and under full head of steam, runs through the fire of the coast-works, and continues its course. During this run, ships especially assigned to the work should direct a lively fire on the mine firing-stations, in order to confuse the operators, and thus, if possible, diminish, in a measure, the danger to the fleet. At the same time, the coast-works are bombarded by the rear guard of the fleet, and taken in reverse by the advanced guard which has already passed the mine-lines.

The ranges at which ships should carry on the decisive combat depend upon the capability of their guns, on the strength of their armor, on the execution of the coast-guns, and the strength of the forts, as also on local conditions, such as the nature of the channel, the elevation of the works above the sea-level, etc.

In order to fire with as much precision as possible, it is recommended that the ships approach the works as close as practicable, thus, as some authors deem advisable, up to one thousand or even eight hundred yards.

Müller, in his "Entwicklung der Schiffs und Küsten-Artillerie," says that "the ranges of six hundred to eight hundred metres only are, as a rule, suitable for the fire of ships against armored batteries."

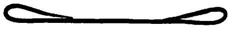
Capt. Barabino holds that the ranges of one thousand to fourteen hundred metres are the most suitable.

The powerful coast-guns, whose projectiles pierce great thicknesses of wrought-iron armor, will, however, keep the ships off at longer ranges, — twenty-five hundred yards and over. The 40-centimetre (16-inch) Krupp gun, of 35 calibers length, will pierce 66.5 centimetres (over 26 inches) of wrought-iron armor, at a range of twenty-five hundred metres. The 100-ton Armstrong will pierce over 23 inches, and the 81-ton Woolwich will pierce over 22 inches, of wrought-iron armor, at a range of twenty-five hundred yards.

In view of the great penetrative power and the accuracy of the coast-guns, the fleet will generally keep in motion. The speed, however, in order not to sacrifice accuracy of fire, must be quite small. Capt. Barabino estimates this speed as under three sea-miles per hour, or one-fourth to one-fifth of the maximum speed of war-ships. We may assume that generally the average speed of a ship during the fight will be about three hundred feet per minute, and in a contracted channel less.

But the ships may decide to deliver stationary fire: in fact, professional authors generally refer to the delivery of fire at moderate speed or at rest. At the bombardment of Alexandria, the ships carried on the fire, as far as practicable, at rest; but in that case the coast-guns were inferior in kind and power.

In reply to the statement of Capt. Walford, R.A., that "from these statements I draw the conclusion, that, in future bombardments, it is probable that ships will attack forts at a range beyond the armor-piercing power of ordinary projectiles," Vice-Admiral Boys stated, "That range is so very vague and unlimited, that I do not think it can be considered as a conclusion drawn from what happened at Alexandria. I do not say where the ships should be, but I think in future bombardments it must be left entirely for the admiral in command to decide his distance, or whether his ships shall fight under way, or at anchor, according to the circumstances of the case, — such as the nature and armament of the batteries or other defences, the proficiency of the garrisons as gunners, and the navigable condition of the locality."

It may be assumed, however, that, in an engagement with forts, ships will either defile past the forts, following one another at fixed intervals, and delivering fire one after another before arriving opposite to the forts, or to each ship will be assigned a fixed radius, within which it will circle, or describe a figure like this , the rectilinear portion of which is perpendicular to the plane of fire, and the turning curves of which lie away from the forts; or they may run end on, firing the guns on arrival at a certain distance from the forts, previously decided upon. This mode of attack will be followed especially by the turret-ships, and also by the casemate and bow-battery ships, if it be not a question of bringing the greatest number of guns to bear. In order to present as small a target as possible to the fort-guns, the broadside and battery ships will, as soon as they have fired, turn quickly, so as to bring their keels in the plane of fire.

Before coming to a standstill, ships run some distance after the engines are stopped. Professor Reynolds states that "the distance required to bring a screw-steamer to rest from full speed, by the reversal of the engines, is independent, or nearly so, of the power of her engines, but depends upon the size and build of the ship, and is generally between four and six times the ship's length."

To turn completely round without the use of steam, but simply by the rudder, about one and one-half minutes are necessary; and the ship does not immediately obey the helm, but runs one and a half to two lengths farther still. The diameter of the turning-circle depends upon the size of the ship, the rudder-angle, etc. Capt. Fremantle, R.N., says, "We may assume the ordinary man-of-war to turn in four and one-half times her own length at high speed, and a double-screw ship in about four times her own length."

In the table of the turning power of the "Lord Warden," the quickest time is 3 minutes 49 seconds, and the least diameter of circle is 1,158 feet. The table also shows, that, at eight-knot speed, the diameter of the circle was only five yards less than at twelve-knot speed, while the time of turning was 2 minutes 1 second more; and, if we take five knots as the speed, the diameter of the circle is reduced by only ninety-nine feet, while the time increases from 3 minutes 49 seconds to 8 minutes 53 seconds.

From these statements it is to be seen that the movements of the ships during a fight render it difficult to aim, and fire at the right time, the guns, not only of the coast-artillery, but also those of the ships. For this reason, the ships will probably make use of deliberate stationary fire at the ranges decided upon. They will make use of rapid fire only against open and low-lying batteries, in order to drive the garrisons from their guns. For this purpose machine-guns will be of great value.

Ensign McCarteney, U.S.N., in referring to the attack on Alexandria, states, "The Nordenfeldt guns, I am told, caused great destruction among the men. . . . The attacking ships, starting from a range of from three thousand to five thousand yards, finally closed in to eight hundred yards; thus giving an excellent opportunity to develop the usefulness of these very effective modern additions to the armament of our vessels."

Lord Charles Beresford, R.N., who commanded the "Condor" at Alexandria, states, "I may also add that two Egyptian officers, who were prisoners under my charge when chief of the police at Alexandria, told me through an interpreter, that the Egyptian gunners would have laid their guns much better if it had not been for the moral effect produced by the continual hail of bullets going over their heads."

He further states, that each of the three following classes of guns should have their place in every man-of-war: —

A. The rifle caliber-gun. Caliber, .45.

B. The torpedo defence gun. Caliber, 1″.

C. The shell and two-pounder gun. Caliber, 1.5″.

In reference to the "*C*" class, he says that it "would be invaluable *in attack*," and "would seal the fate of an action between two otherwise equally armed ships."

The machine-gun adopted for the United-States Navy is the Hotchkiss, of which it has 43. The numbers in use in the principal European navies are as follows: English, 566 one-inch Nordenfeldt and 3 Hotchkiss; French, 752 Hotchkiss shell-guns; German, 303 Hotchkiss shell-guns; Italian, 42 one-pounder Hotchkiss shell-gun, and 100 one-inch Nordenfeldt; Russian, 106 one-pounder Hotchkiss shell-gun, and 37 one-inch Nordenfeldt (Palmcrantz); Austrian, 42 one-inch Nordenfeldt, and 16 two and one-half pounder Hotchkiss shell-gun; Spanish, 24 one-inch Nordenfeldt and 1 Hotchkiss. "Of the Gatlings, 300 have been delivered to England, 500 to Russia, 600 to Turkey, and smaller numbers to other countries."

CHAPTER III.

COAST-DEFENCE.

In considering the question of coast-defence, those harbors are of the first importance which contain arsenals or navy-yards, and which, besides being those in which our own fleet is fitted out, and organized for offensive operations, are also the natural places of refuge for that fleet, in case of defeat or disaster.

In addition to such harbors, defences should be provided at —

1. Those points which command good anchoring grounds, whose depth is such, and which are so sheltered from the prevailing winds, that the enemy will seek to occupy them in stormy weather.
2. Those points which command good harbors and roadsteads, which the enemy may seek to utilize as bases for further operations by sea or land.
3. Those points which command the channels which the enemy is forced to enter, such as straits, entrances to bays, mouths of large rivers giving access to the interior of the country, and especially commercial ports and harbors.
4. Those points which it is necessary to protect from a bombardment by the enemy's fleet, such as open harbors, commercial or manufacturing cities (especially the richest), and eventually, in the course of the war, those portions of the shore along which run, within range of the enemy's guns, a forced line of operations of our own army.

5. Points of the coast at which the enemy may attempt to land.

The means necessary for a successful coast-defence may be classified under three heads; viz., —

(1) Movable defences (*défenses mobiles*).

(2) Stationary defences.

(3) Accessory defences.

The first of these implies a fleet charged with watching the coast, and land forces which are held in readiness to move rapidly to the menaced points.

Following the designation of the European powers, we may classify the different points to be defended as war-harbors and fortified-harbors or coast-points.

War-harbors have generally to play a *rôle* similar to, but greater than, that which devolves upon fortresses of Continental fortifications. They should be able to protect their own fleet, as well as the arsenals, docks, wharves, etc., — or, in other words, to resist any attack of the enemy by land as well as by sea. They should therefore be defended, on the land as well as the sea side, by a girdle of forts and batteries; and these latter should be of such strength that they may successfully resist a real attack by sea, and both open assault and siege in form by land. In addition to the girdle of forts there should be a nucleus (*noyeau*).

Since large disembarkations are difficult of accomplishment, and the enemy will not resort to protracted operations against the less important fortified-harbors and coast-points, it is only necessary to construct fortifications of such a nature that they will be able to resist a bombardment from the sea, and relatively feeble assaults of naval forces.

The most effective method of defending a harbor or seaport against a bombardment is, as in the case of a land-defence, to establish the forts and batteries at such a distance from the objects to be protected, that the latter cannot be reached by the most powerful naval guns. In case, however, the configuration of the coast renders such a disposition impossible, and the depth of water be such as to preclude any idea of constructing forts on artificial sites, then it is evident, that, next to our own fleet, the only resource is a *numerous and powerful armament.*

The resistance of a coast-fortification to an attack by sea depends especially on the number and defensive strength of the individual forts and batteries, and on their armament.

The same principles which govern the disposition of interior fortifications apply in general to coast-fortifications. "The modifications which distinguish coast-defences from land-defences in general are due chiefly to the characteristics of the enemy they have to oppose."

As, in deciding upon the fortified and artillery strength to be given to the different fronts of land-defences, more attention is paid to those which are likely to be besieged than to those, which, by their location, are less likely to be menaced, so, in the case of coast-defences, particular attention is paid to those fronts which are more favorably situated for bombardment, or which are more exposed to an attack by sea.

The formation of the coast, the character of the channel, etc., are of the first importance. For the most part, however, it will be necessary to most strongly fortify and arm those fronts, which, lying next to the harbor-entrance, the enemy will have to silence, or seriously cripple, before forcing an entrance. The size and the number of the works will be determined by the importance of each front, consequently its strength, and also somewhat by the number and character of the points suitable for the location of forts and batteries.

As the attack on land-defences is especially directed against very advanced forts, or against those fronts which form an acute angle, so will also a fleet — which, as far as the attack is concerned, is governed by the same principles which are applied in sieges — devote its attention preferably to the advanced works. In order that these may not be quickly reduced, they should be made large and strong, and that so much the more, the less they can be supported by the neighboring works. On the other fronts it is admissible to establish the individual forts and batteries at greater distances from each other, depending upon their size and strength. They should, however, always be disposed with reference to mutual support, since one cannot, as in the case of land-defences, resort at the last moment to provisional works established in the intervals.

As further considerations to be observed in the choice of locations for the outer girdle of forts, are to be mentioned the special duties to be performed by the forts. For example, if the fort is to command a landing-place which might be used by the enemy, the construction and armament of the fort will be determined by the nature of the landing. If the landing can be made under the protection of the armored ships, then strong forts with heavy armaments are necessary. If the landing can be made only with small boats, then the forts may be armed with siege or even lighter guns.

The disposition of coast-forts which are to be subjected to an attack by sea will depend chiefly upon the nature and shape of the harbor-entrance and of the harbor itself. Comparatively narrow entrances, or narrow parts of the same, can be rendered impassable, for a time at least, by means of submarine mines and obstructions. In order, however, that these may be effective, a powerful flank-fire from one side, at least, is necessary. If the width of the channel be such that two or more ships can approach the obstructions at the same time, then a flanking fire from both sides is necessary. The works erected for this purpose should be so disposed that they cannot be bombarded from a distance, nor be prematurely destroyed. In long entrances the great development of shore will be utilized for the erection of numerous batteries, both in front of and behind the lines of obstructions; and, as armored ships (with the exception of turret-ships) can use only one-half of their guns against a given battery, it may be necessary to erect batteries on only one shore, if the channel be so narrow that the ships are forced to follow one behind the other.

That portion of the harbor-coast lying in the prolongation of the entrance should be lined with mortar batteries, since a gun projectile fired at the bow of a ship produces little or no effect.

In general terms, the problem of coast-defence is almost entirely one of locality.

The Chief of Engineers, U.S.A., in his annual report for 1881, says, —

"Our fortifications and torpedoes, then, must close all our important harbors against an enemy, and secure them to our military and commercial marine; second, must deprive an enemy of all strong positions, where, protected by naval superiority, he might fix permanent quarters in our territory, maintain himself during the war, and keep the whole frontier in perpetual alarm; third, must cover the great cities from attack; fourth, must prevent, as far as practicable, the great avenues of interior navigation from being blockaded at their entrances into the ocean; fifth, must cover the coastwise and interior navigation; and, sixth, must protect the great naval establishments. In these places are to be found objects that are in every sense of the highest value. On the one hand, we see accumulations of military and naval material, and structure for naval accommodation, that could not be replaced during a war, which are of indispensable necessity and of great cost, and, on the other hand, the untold wealth of great cities. As these objects must be great in the eyes of the enemy, — great for him to gain, and for us to lose, — corresponding efforts on his part must be looked for and guarded against.

"There should now be stated in a few words our system of seacoast defence, — a system steadily pursued from the first by this department, but modified, from time to time, as new improvements in attack and defence of coasts have been introduced.

"Fortifications must command, from the shores exterior to our harbors, all the waters from which the enemy can reach our cities and navy-yards with his shot and shell. The harbor-mouths, and all the narrow passes within them, must also be occupied; and, if Nature has not afforded all the positions deemed requisite, others must, if practicable, be formed artificially. Fortifications should succeed each other along the channels of approach, and in our harbors; so that the enemy may nowhere find shelter from our fire while lying within our harbors, should he succeed in passing the outer lines of works. The harbor mouths and channels must be obstructed by lines of electrical torpedoes, for holding the enemy's vessels under fire of the fortifications, previously constructed, and stored in the latter, and laid, on the advent of war, in systems the plans of which have been carefully elaborated in time of peace by studies of the local charts and tidal currents; each harbor having its own system recorded in this department. The wires for conducting the current from the electric apparatus on shore must at the same time be laid securely in subterranean galleries carried out to deep water; and the electric machines themselves, the hearts of the torpedo system, must be placed in chambers within the fortifications, hidden from the enemy, and secured beyond all peradventure from his direct and curved fire. These galleries and chambers must be covered with heavy masonry arches and great masses of earth; and the former, to be efficient, must be indurated, and the latter compacted by time.

"Heavy mortars must be placed in large numbers to command all those positions where an enemy is likely to anchor within their range, either for the purpose of tampering with or destroying our torpedo lines, or shelling our cities, and public depots of military and naval supplies. The efficiency of mortar-batteries against shipping is acknowledged by all military engineers; it is fully appreciated by the navies of all nations; and they are comparatively inexpensive."

Gen. Gillmore says, "The great first cost of vessels-of-war, their perishable nature, and the growing expense of preservation, repairs, and renewals, exclude a defence by naval means from more than a moment's consideration, except for those points — fortunately of rare occurrence — where adequate protection cannot be obtained by the cheaper method. Notwithstanding its excessive cost, however, it is necessary to resort to this method of defence, when the channels of approach to bays, sounds, and other partially land-locked waters, are too wide to be effectively covered by land-batteries, if we would withhold these waters from use and occupation by the enemy. Long-Island Sound and Delaware and Chesapeake Bays would have to be relinquished to a naval adversary, unless held by naval means. Fortifications at suitable points, however, even in these isolated cases, are necessary auxiliaries to the defence by a fleet, in affording safe places of refuge for our mercantile marine, and points of rendezvous for our vessels-of-war, before taking the offensive, or in case of disaster or defeat. But, in nearly every case, the channels leading to good harbors, to cities, large towns, and important establishments, are sufficiently restricted in width to be effectively defended by shore-batteries and their accessories."

The constituent parts of a stationary defence are, —

A. Coast forts or batteries.

B. Obstructions.

C. Submarine mines.

The accessory defence consists of torpedoes, torpedo-boats, floating-batteries, and the like.

CHAPTER IV.

COAST FORTS AND BATTERIES.

As a rule, by the term "coast-forts" is understood those defences which are armed only with guns which are intended for piercing the side armor of ships; and, since it is that component of the projectile's energy which is normal to the side of the ship that does the work, the forts should not be situated too high, that is, more than seventy-five to a hundred feet above the sea-level.

Coast-batteries are either for mortars or guns which can be fired at great elevations. As the fire is directed mainly against the ships' decks, the greater the elevation of the site, within reasonable limits, the better.

The terms "fort" and "battery" are, however, interchangeable; and we may say that modern coast-fortifications are, according to their construction, —

Open unarmored batteries,
Armored batteries,
Armored revolving turrets.

England has devoted a great deal of time and money to the development of combinations of stone and iron, and to-day she has large batteries of that description. It is only for the reason that they exist, that they are referred to in this work. Their day has passed, and they are of interest simply as a stage of development. The Board of Engineers, U.S.A., in its report for 1881, says, "The combination of iron shields with masonry scarps, regarded as admissible some years ago, is not now looked upon with the same favor: in fact, the development of the eighty and one hundred ton guns, the improvement in projectiles, and their initial velocities, seem to have rejected that method of construction for forts."

The English argument for the use of such batteries is set forth in the following extract, taken bodily from their latest text-book of fortification: —

"When the site is confined, and many guns are required, it becomes necessary to place them at closer intervals, or even tier above tier. Stone or iron must take the place of earth, and casemated batteries must be made. This construction has some attendant advantages which may recommend it where it is not absolutely imperative. It gives security against vertical fire, and, when the ground rises steeply behind, against the fire of infantry from the rear, or against splinters of rock or shells. Also, 'whilst in an open earthen battery the barracks, magazines, and other accessories have to be provided for separately, and the defensive enclosure must be of large area and in addition to the battery, in a casemated work, the battery, barracks, magazines, etc., are provided under the same roof, and the defensive enclosure, which is comparatively small in extent, is formed by the casemated structure itself.' On the other hand, however, the crowding of the guns in casemates is attended by many inconveniences. They interfere with each other's service, especially by the accumulated smoke: they offer an excellent target to the enemy's concentrated fire. If a shell enters by a port, the damage done is in proportion to the crowding; and the accidental blowing-up of a magazine is far more disastrous than in the case of an open battery.

"Until the introduction of rifled ordnance, casemated coast-batteries were wholly of masonry, with front-walls five or six feet thick, and splayed embrasures having a large external opening. The increased power and precision of artillery made it necessary to substitute iron for masonry at the embrasures, in order both to reduce the size of the opening and to strengthen its margin. The iron border has grown by degrees into a shield, generally similar in size and structure to the shield already described for earthen batteries; and the masonry between the embrasures has been thickened into solid merlons of about twelve by fourteen feet, which, together with the arches over the shields, are usually faced with granite. The guns are eight yards apart, and have a lateral range of from fifty to seventy degrees. The rear of the casemates can be used for barrack-rooms, being closed by a slight partition, which can readily be removed, wholly or in part, when the guns are to be used; so that the battery may then be open behind, and consequently more clear of smoke. The magazines are under the gun-floor; the lifts for the cartridges being close behind the merlons, and those for the shells farther to the rear.

"The stability of the shield should not be dependent upon the endurance of the merlons. It is kept in position mainly by the base-plate of the shield-frame, which, besides being carried into the merlons, is bolted down to the bedstones. Sometimes, also, heavy dovetailed bars are let into the bedstones, having raised studs behind the base-plate. It is very important to guard against the shield being driven backwards, as a slight displacement would disturb the front racer, and so interfere with the working of the guns.

"In 1865 at Shoeburyness a casemated battery of this description was heavily battered by nine-inch and ten-inch guns at short ranges. The effect on the merlons led the experimental committee to the conclusion 'that granite should, if possible, not be used in exposed parts of the structure of forts liable to be regularly engaged by heavily armed iron-clads . . . and that it would be far preferable to provide forts in such situations with external defences entirely of iron.' The test, however, was a very much more severe one than any ordinary engagement with vessels would have been; and while it led to the adoption of wholly iron-fronted works for prominent and important positions, where they would be exposed to exceptionally heavy battering, it did not show that the use of masonry, which is much cheaper than iron, is inadmissible for more retired works. Such works, if destructible, will take a long time to destroy; and American officers, after their experience in the civil war, deny that ships can maintain the contest long enough for the purpose."

The open unarmored battery, although it is often represented as no longer in keeping with the spirit of the age, is, in spite of the power of modern naval guns, to-day applicable to locations sufficiently high above the level of the sea.

The projectiles even of the heaviest guns penetrate an earthen parapet only to about fifteen to eighteen feet, and at this depth often change their course, and come out on the superior slope. This was shown at Alexandria. Capt. Walford, R.A., in his lecture on "The Effects of the Bombardment of the Forts of Alexandria, July 11, 1882," stated, "The fact remains, that, under present conditions, even heavy guns will fail, at a mean range of twenty-five hundred yards, to penetrate a twenty-four-foot parapet; and this is the case, not because modern shells are wanting in weight or velocity, but because, while traversing a parapet, they are forced into a false direction."

Ensign McCarteney, U.S.N., in referring to Fort Ada at Alexandria, states, "Several projectiles were found embedded in the sand at this fort, and were in good condition, having failed to explode, from the lack of resistance opposed to them. One large eighty-ton gun battery-shell from the 'Inflexible' was found unexploded upon the parapet, and pointing seaward. In conversation with the gunnery-lieutenant of the 'Invincible,' I learned that many projectiles were found thus."

Ensign Gleaves, U.S.N., in referring to Fort Mex, says, "In considering the effects of the heavy cannonade on this fort, it is noticeable that the fortification was injured very little. The damage it did sustain could have been easily repaired in a few hours."

Capt. Walford says, "Should, however, the shell fall on the superior slope, it will almost certainly pierce what remains of the parapet, and will tear away some yards of the interior slope."

In firing against the parapets of elevated coast-batteries, the above-mentioned penetrations will hardly be attained by naval projectiles, let alone exceeded. An earthen parapet thirty to forty feet thick will therefore sufficiently protect the guns and garrisons against shot striking it. The English text-book lays down the rule, that "the parapet of a barbette-battery should consist of at least ten feet of concrete and seventeen feet of earth. Loam or clay should not be used for the latter: sand stands best under shell-fire."

As regards the latter statement, Gen. Gillmore, in his report upon the siege of Charleston, says, "The powers of resistance of pure compact sand to the penetration of projectiles very much exceeds those of ordinary earth, or a mixture of several earths; and in speaking of earth-works a capital distinction should be made between those formed of quartz-sand, and those that are not.

"Against the destructive effects of projectiles, pure quartz-sand, judiciously disposed, comports itself unlike any other substance, and for certain parts of fortifications its peculiar properties suggest its exclusive use in preference to ordinary earth."

The Chief of Engineers, U.S.A, in his report for 1879, in referring to modern seacoast guns, says, "The parapets, and traverses of earth and sand to protect them, must be three and even four times as thick and massive as they were formerly built to resist the armaments of twenty years ago. Where the parapets of earth were but ten feet in thickness, now they must be forty feet."

Capt. Brunner, of the Austrian Engineers, says that the parapet should be at least twelve metres (39.37 feet) thick, if the ships can approach to within effective range. The German text-books recommend the same thickness.

The higher the location of the open battery, the greater is the protection afforded by the parapet, especially at the short ranges of eight hundred to one thousand yards; for the reason, that, on account of the increased elevation of fire of the ships' guns, the projectiles pass the parapet on the ascending branch of the trajectory, and hence do not endanger the interior of the battery, if there be not behind it a steep slope of ground in which the shells may explode, and by their fragments injure or worry the men serving the guns.

Capt. Walford, in referring to the bombardment of Alexandria, says, "Speaking roughly of the shots which have hit the forts, fifty per cent have passed over the parapets, thirty-three per cent have struck the escarp, and about seventeen per cent the parapet."

It is very important that a sufficient height be given to the parapet. Capt. Walford holds that the parapet of a coast-battery should be certainly ten feet high, of which nine feet should be revetted. He says, "It is absolutely necessary that the rear of the gun portion should be enfiladed, at least from the bullets of shrapnel and machine-guns. Less than ten feet of parapet will not afford such cover; for, given that the bullets fall at an angle of ten degrees (about one-sixth), such a parapet yields only six feet eight inches of cover at a distance of twenty feet from the crest. The number who lays the gun must, under the present system, be always exposed to fire, though he can find some cover behind the breach. No mention has been made of defilade from the fire of heavy shell, since it would appear, from the results at Alexandria, that such a missile, if it strikes the superior slope within six or eight feet of the crest, must shear away any parapet or revetement. Fortunately, it would seem that such hits are as rare as they are destructive in their effect."

The English text-book lays down the rule, that "the general level of the gun emplacement should be nine feet below the crest; but, to suit the ordinary traversing platform, the immediate *terre-plein* of the gun must be raised two feet eight inches above this level. There is a step in front, and a ramp in rear, to mount on to this *terre-plein.* It is of concrete, with blocks of stone to carry the iron racers upon which the platform works. Where wide lateral range is required, one continuous circular racer (known as *C* pattern) is used; and an old gun sunk vertically in the centre of the *terre-plein* serves as a pivot. Rails are carried round the front of the *terre-plein;* and on these travels a wooden loading-stage about five feet long, and three feet seven inches high, upon which the gunners mount to load the gun. This stage can be run back to the rear of the emplacement, to receive and bring up the shells for very heavy guns."

Ordinary embrasures should not be employed, except on a front which commands a navigable channel of comparatively little width. They are a source of weakness in the parapet, and restrict the lateral range of the guns.

The interior slope should always be revetted with granite or concrete, to render more difficult the destruction of the parapet, to save room, and to protect the gun-carriage. This revetement should not be carried all the way up to the interior crest, and the latter should be finished off with a reverse slope.

A parados should be provided in rear of each face, in order that the remainder of the work may be protected. "For parados in general, and especially for those exposed to the fire of heavy artillery, earth may be considered better than sand, when it has been cleaned from gravel and stones." The Italian experiments seem to show, that, if the work be exposed to the fire of the more powerful guns, the parados should be so placed, that the distance of the foot of their interior slopes from the end of the gun platforms should be thirty metres; but that this limit may be somewhat reduced, if the batteries be well elevated above the level of the attacking gun.

The battery should be liberally supplied with traverses, in fact, there should be only one gun between each two traverses; and "the guns must be widely spaced, twenty to thirty yards apart, in order that the traverses may have sufficient solidity." Capt. Brunner states, that, to resist an enfilading fire, the traverses should have a thickness equal to that of the parapet; that for a slant fire they may have only two-thirds of that thickness, but they should be at least 3.2 metres (10.5 feet) thick; and that they should command the interior crest 1.6 metres (5.25 feet). The English text-book gives the traverse a height of twelve feet above the gun *terre-plein*, or 7 feet 7½ inches above the interior crest of the battery, for a ten-inch gun. The Prussian text-books give the traverse a height of 3.9 metres (12.89 feet) above the gun *terre-plein*, and 1.9 metres (6.25 feet) above the interior crest.

As by this construction the battery is sharply indented, the crest line will stand out in bold relief, particularly if well elevated and the sky forms the background: hence the position of the guns is sharply defined to the enemy. The Prussians, on this account, plant trees behind the interior slope. Capt. Walford says that batteries should not be conspicuous objects on the coast, and continues, "The real difficulty of the case lies in giving considerable elevation to a battery, without making it conspicuous; but in practice what is required is, not that the whole fort shall be invisible, but that the position of the guns shall not be marked in such a manner as to render them visible at long ranges. The Egyptian parapets and escarps were of the same color, being covered with the same gray cement; and we have all heard of the difficulty which was experienced in seeing the guns. From this it follows, that, whatever may be the material of the, so to speak, pedestal of a coast-battery, the actual parapet which covers the guns should not be easily distinguished from whatever background may be behind it."

As a rule, the construction details of all kinds of coast-batteries are determined by boards of engineers in each country; and official plans and specifications for each locality are furnished to the officer immediately in charge of the construction.

It would be going beyond the limits of this work to give descriptions of the various kinds of earthen barbette-batteries; and a sufficiently general idea may be gathered of the principles of their construction by referring to Figs. 16, 17, 19, which represent an English battery, and Fig. 18, which represents a Prussian battery.

The open, unarmored gun-battery should at least have the same elevation as the maintops of war-vessels, and in no case less than twenty-five feet, in order not to be commanded by the turrets of armored ships. At these lower elevations, it is claimed that the guns should be mounted on depressing carriages, so that the gunners may be sheltered by the parapet while loading.

In his report for 1872, the Chief of Engineers, U.S.A., says, "By the use, however, of high sand parapets, behind which the gun, when fired, shall descend, and by covering these guns on either side with high traverses, a combination is obtained which is at once secure from direct and slightly curved fire, whether from the front or flank, and substitutes sand, a cheap material, for the costly iron shields and turrets.

"It is absolutely essential, however, that a carriage that shall lower the gun below the parapet be provided in order to secure these benefits."

Gen. Gillmore says, " With a suitable gun, and a depress-

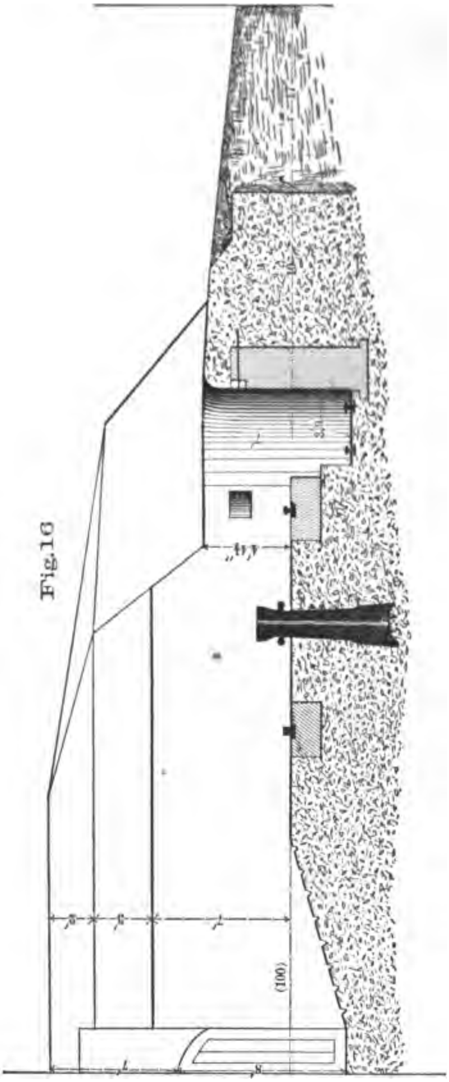


Fig. 16

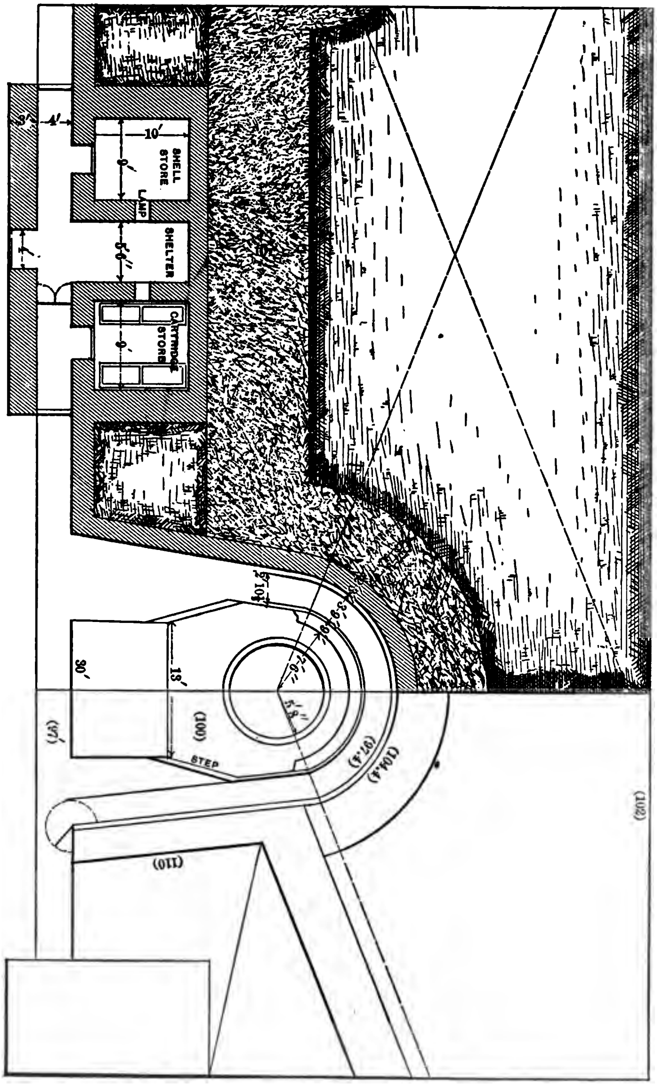

SHELL STORE
SHELTER
CARTRIDGE STORE
LAMP
10'
9'
5'6"
9'
4'
3'
4'
5'10½
3'9
7'6"
5'8"
13'
30'
(100)
(97')
STEP
(97.4)
(104.4)
(102)
(110)

Fig. 17

Fig. 18

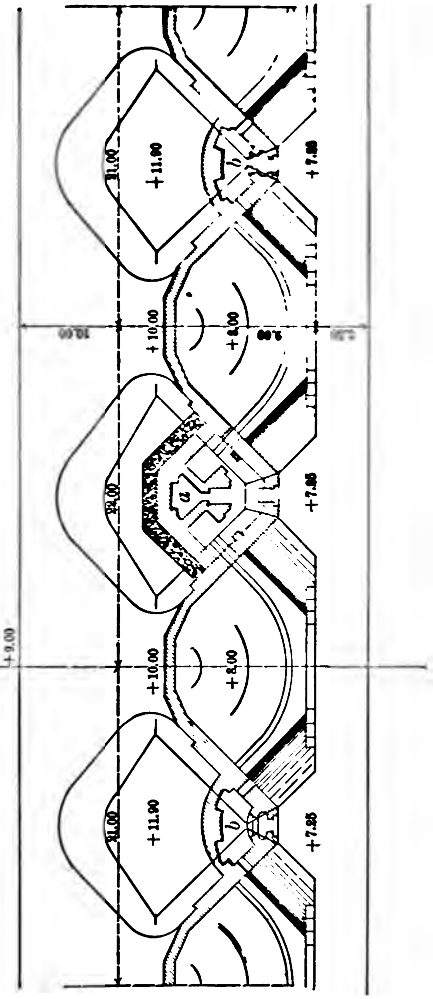
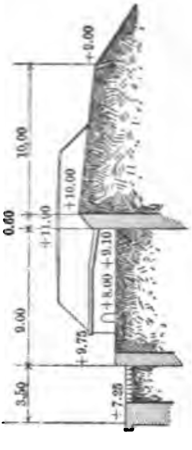


Fig. 18a



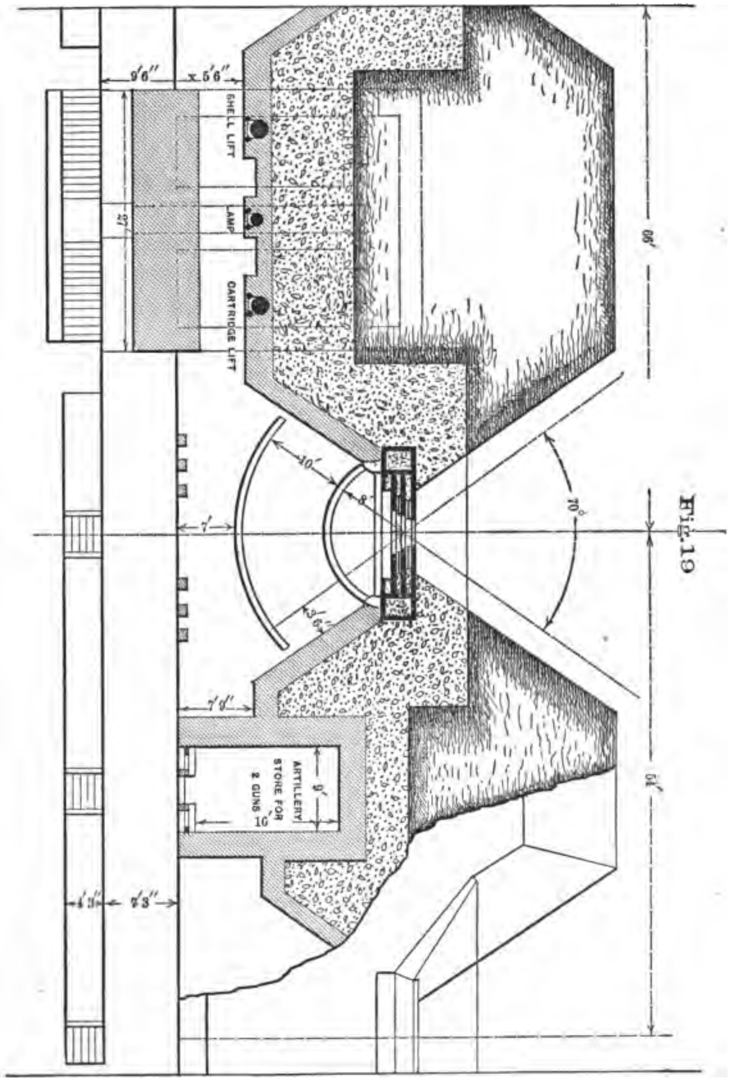

9'6"
5'6"
SHELL LIFT
LAMP
CARTRIDGE LIFT
27'
10'
8'
7'
3'6"
70°
60'
70'
7'9"
ARTILLERY STORE FOR 2 GUNS
9'
16'
4'3"
7'3"

Fig. 19

ing carriage provided with a grape or canister proof shield, or some equivalent device, to protect the gunner just before firing, all of our open batteries would be reasonably safe."

The English text-book says, "For the lighter kinds of armor-piercing guns, especially if near the water-level, Moncrieff or disappearing carriages are of great value. They give security against direct fire to the gunners, and, except at the moment of firing, to the guns; also they can be used in pits or sunken emplacements, offering no target to the enemy. On the other hand, if any thing goes wrong with a gun so mounted, there will be much less chance of bringing it again into action."

Capt. Bixby, in his report to the Chief of Engineers, U.S.A., says, that in Europe there is an "increasing dislike to the use of Moncrieff and other similar too expensive and too complicated disappearing-gun gun-carriages."

There are varying opinions as to the value of earthen barbette-batteries. We find as high an authority as Gen. Gillmore saying, "Indeed, in these open batteries, unless exceptional circumstances favor their being scattered in single guns over a long line, it might not be possible to serve the guns at all, even for a brief period, against armored ships showering grape and canister from large guns, and leaden bullets from machine-guns and other rifles. The protection of the cannoneers at their pieces is certainly a consideration of the highest moment. It is indeed an essential consideration.

"The lessons of our civil war and of all modern wars, so far as justifying a recourse to earth-works for channel defence, all point the other way. At Port Royal, our fleet, although composed of wooden vessels only, drove the garrisons precipitately from their works on both sides of the harbor. In the operations before Charleston it was no uncommon sight to see the 'New Ironsides' alone silence the fire of Fort Wagner (a very strong earth-work), so that the work in the trenches could proceed unmolested; and on our western waters 'running' a battery, or 'silencing' a battery by such a shower of small missiles as would drive the cannoneers from their pieces, became almost every-day occurrences, the important question in such cases being whether the channel itself was free from obstacles."

On the other hand, Admiral Sir Astley Cooper Key says, "I entirely concur in the use of earth-works as against ships, in preference to masonry or brick-work. I think this is one of the most important points we can insist upon. There are positions, like Spithead and others, where you cannot have earth-works; but, wherever you can, place earth-works against ships; and I have for many years come to the conclusion, after considerable personal experience, that earth-works are far more secure for defence than stone-works. I also concur in the view of placing the work high above the water-level, up to about one hundred feet. I do not think it is wise to place it above that; but from sixty to eighty feet is the best height for batteries to be placed. I would also place the batteries inland at various distances, if possible, and that the ships could never approach them within two thousand or twenty-five hundred yards."

The Duke of Cambridge says, "In forts in the sea, sometimes, you could not make them of earth: therefore, with that reservation, I think, that, whenever it can be done, the most efficient sea-batteries as against a fleet are decidedly earth-batteries."

The English text-book says, "Earthen barbette-batteries give wide lateral range, and if well constructed, and suitably placed, they are perhaps the best, as they are also the cheapest, form of ordinary coast-battery, even for very heavy guns. But they should not be less than one hundred feet above the water, if the guns are to be mounted on ordinary carriages: otherwise the guns and gunners will be very much exposed."

It is well to state here that all open batteries should have a good armament of machine-guns, or an armament of the lighter guns which can fire grape and canister or simply shell. No ship will long remain under a heavy shower of even the smaller missiles, which rattle through the tops, leave no dead space on the decks, rush through the ports, worry the gunners as well as the man at the wheel, and the commander in the conning-tower, while heavier guns are piercing or racking off the armor. If the little unarmored gunboat "Condor" could, with one Nordenfeldt gun in her foretop, drive the Egyptian gunners from their pieces, why could not machine-guns in the fort have driven the Nordenfeldt from the top? There can scarcely be a doubt, that, had Fort Marabout been armed with machine-guns, the English admiral would not have had the opportunity to enrich the literature of war with the well-deserved tribute, "Well done, Condor!"

Admiral Sir Astley Cooper Key says, "There is one point, with regard to the construction of forts, that I think might be added; that is, the great advantage such works would have if they had a number of smaller guns in addition to their heavy ordnance. A large proportion of the exposed hull of the ship is unarmored, and penetrable by sixty-four-pounders; and I believe that any works against which ships could be brought would have very much increased power if they had a considerable number of small shell-guns in addition to those for penetrating armor. We are adopting this system in our ironclads, and I think the same rule holds good with regard to fortifications."

These smaller calibers and the machine-guns need not be mounted until actually needed, and thus, by not being exposed, be safe.

There should be no magazines of any description exposed to the fire of the ship's guns. No ammunition should be stored in the traverses. The latter should serve simply, as far as ammunition is concerned, as covered outlets for the ammunition-lifts from the magazines below. The use of "expense magazines" is unnecessary, and, what is more, dangerous. Several small magazines are better than one or two large ones.

The Board of Engineers, U.S.A., in its report for 1882, says, "By reason of the increased weights and improved forms of projectiles, the greater lengths of guns, and much enlarged powder-charges, penetration by shot and shell into iron, masonry, and earth, has been more than doubled since our seacoast batteries were planned. To meet these changed conditions, so large an increased care for magazines is demanded as to require that they should be sunk quite below the *terre-plein* for protection."

They should be provided with lifts and wagons running on rails to each gun. Every facility favorable for rapidity of fire should be adopted.

As other advantages of the open battery, there may be stated, that its guns may be fired under the greatest elevations, and thus attain the value of mortars; and, again, a great many of the injuries received during the day may be easily repaired at night.

This discussion of open, unarmored gun-batteries, may be closed with the statement, that in spite of the increased thickness of ships' armor, and of the increase in power of naval guns, these batteries — if placed seventy-five to one hundred feet above the sea; if armed with the most powerful guns, and also with a certain number of smaller guns for firing clouds of missiles; if well supplied with traverses and parados, with underground magazines, and bomb-proof shelter for the garrisons — may and will, not only hold their own against ships-of-war, but even have the favorable conditions of combat all on their side.

The open, unarmored battery is the form used almost exclusively for mortars. The same general rules which govern the construction of gun-batteries are to be applied to that of mortar-batteries; that is to say, there should be ample bomb-proof shelter for the garrison, the magazines should be underground and several in number, each mortar should be separated from its neighbor by a bomb-proof traverse. They should be so arranged that the officers in command may be able to overlook the whole field of fire without too much exposure. Since the mortar draws its serviceable effect from the velocity acquired in the fall of the projectile, the greater its elevation above the sea-level, the better. As in the case of gun-batteries, provision should be made for preventing the capture of the mortar-battery by landing troops.

There is one great distinction between gun and mortar batteries, and that is, that while, as a rule, the guns should be distributed in a number of self-supporting small batteries, an accumulation of mortars in one battery is, up to a certain point, desirable.

Gen. Abbot says, "It is very desirable to locate the mortars as near together as practicable, so that the fire of the entire battery may be considered to proceed from a single point. The work should also be concealed from the view of the fleet, offering no target but a substantial earth-covering."

On high points the battery may be entirely sunken at a good distance back from the face of the bluff or slope; thus offering the smallest target, and at the same time the best parapet.

Capt. Walford says, "Some provision should be made for the possible use of vertical fire against ships. For this purpose it would be well that at least ten S.S. thirteen-inch mortars should form a battery, and that these batteries should be placed near, but by no means in rear of, the gun-batteries. The range of any ship which has anchored, or taken up a stationary position, having been obtained from the gun-battery, a salvo should be fired from the mortars, and repeated until the ship is forced to get under way. The Egyptians do not appear to have used their mortars during the defence of Alexandria, for the reason, probably, that on account of their position, which was almost invariably in rear of the guns, it was impossible to keep up a simultaneous fire from both weapons."

Gen. Abbot says, also, "A great advantage in the use of mortars is, that the batteries are much less expensive than those for guns."

In armored batteries, that portion of the parapet immediately in front of each gun is replaced by an armored shield, which, for the better protection of the gun, is provided with a minimum embrasure or port. The gun is mounted on a special carriage, known as the "minimum embrasure carriage."

This species of battery, which gives better cover overhead, and greater protection to the guns against a dismounting fire, than open batteries, is at the same time much more expensive than the latter, and is necessary only for low sites. There are two prominent types in use, — one adopted by England; and the other known as the "Gruson invention," and adopted by most of the European Continental powers (Fig. 21).

The English battery may be best described by the following extract from the text-book: "When ordinary barbette-batteries would be too much exposed, and wide lateral range is not essential, the guns may be made to fire through embrasures protected by iron shields (Figs. 19, 20). The structure of these shields has to be modified with each new advance in the power of artillery; but it seems to be well established, that, instead of one very thick plate, it is better to have three or four plates of moderate thickness, and to interpose between them layers of more compressible material. Against guns of twenty-five tons or less, it is sufficient to provide three five-inch plates bolted together, but separated by five-inch intervals built up with brickwork, and backed by a shield-frame of plate and angle iron filled with concrete. They must be

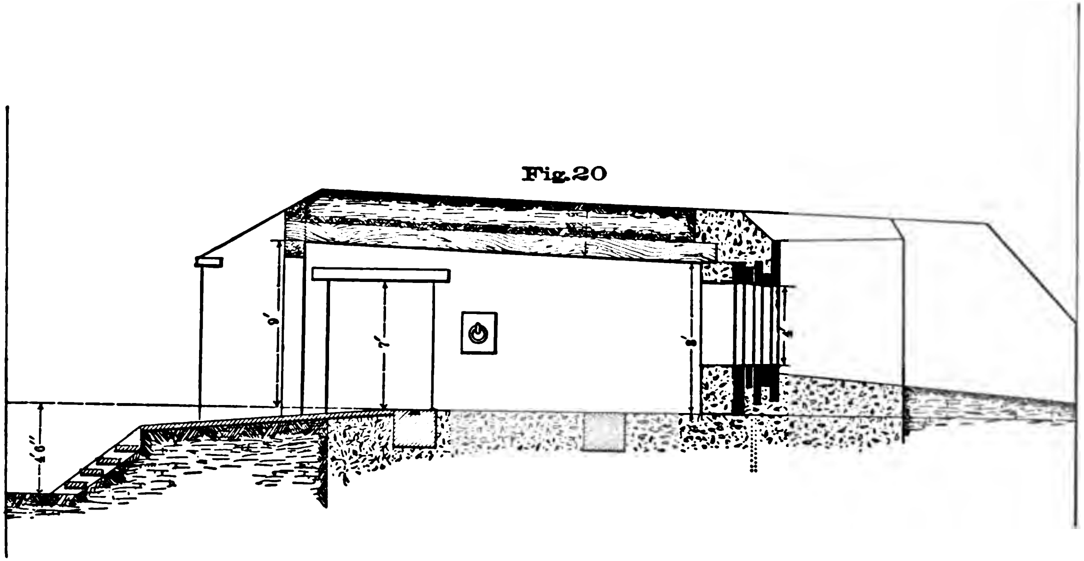
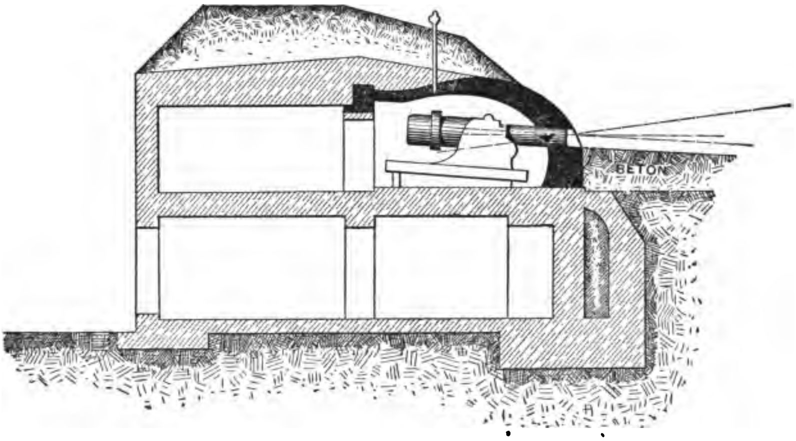


Fig.20

about eight feet high, and twelve feet or more in width. (The 38-ton gun will pierce twenty inches, and the 81-ton gun, twenty-seven inches of iron.)

"The port for the gun to fire through is made as small as possible. The racers are of what is known as *A* pattern,—two concentric arcs, the centre for which corresponds with the position of the muzzle of the gun when it is run up; and this *imaginary pivot* is placed eight inches behind the face of the shield. This allows a 10-inch gun to be traversed through an arc of seventy degrees, with a port only two feet seven inches wide externally. To allow of moderate elevation and depression, the height of the port must be four feet. To prevent the brickwork between the plates being forced out at the port when the shield is struck, iron port-frames are provided.

Fig. 21



"The guns should not be less than about twenty yards apart, and the merlons between them must be very solid. They are carried back behind the line of the shields, so that they serve as traverses for the guns; and they close in on these on either side as much as the required training

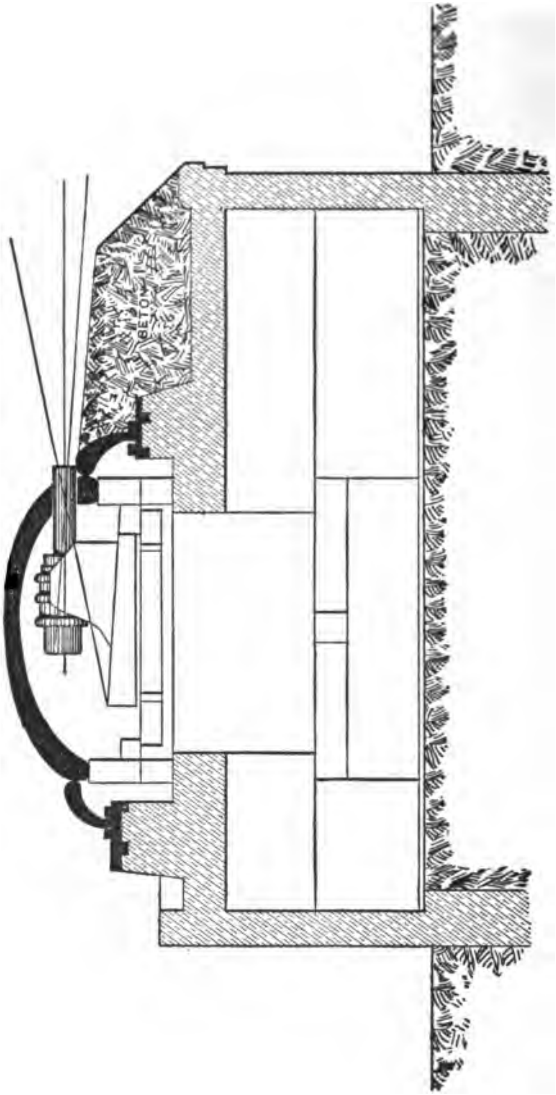


Fig.22

will admit of. Concrete is used to increase their resistance, especially at the checks of the embrasures. The expense magazines and shell stores are placed under the

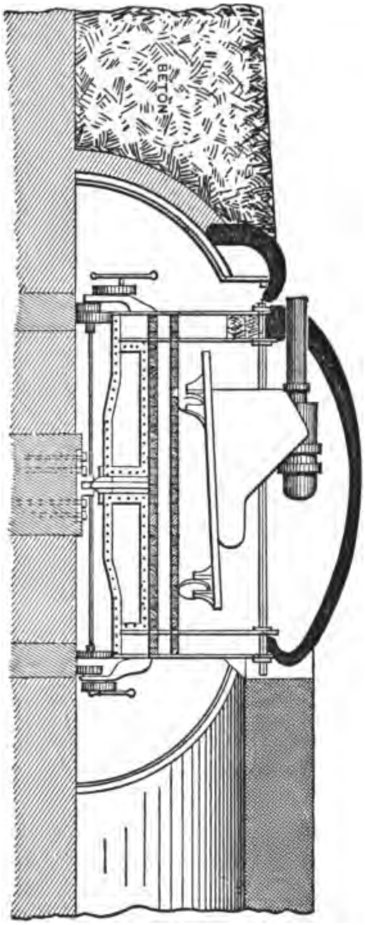


Fig. 22a

merlons, with lifts opening into a covered passage behind the merlons; but, as two guns may be served by one expense magazine, alternate merlons may be made to hold the artillery stores which it is necessary to have near the guns.

"Overhead cover for the guns is sometimes provided, consisting of a concrete roof carried on iron girders and arch-plates; or arrangements are made for their being blinded with timber and earth (Fig. 20) when an attack is expected."

The English have also constructed an iron-fronted battery, the plan of which corresponds generally with the combination stone and iron battery, if we suppose the stone merlons removed, and the plating made continuous. "This iron wall, however, is not backed, as the shields are, by frames filled with concrete. Behind it, and bolted to it, there is at its base a continuous box-girder, sunk into the stone floor, and at its top another box-girder, which is riveted to the girders and arch-plates which carry the concrete roof. The floor and roof, therefore, together sustain the front wall, which has usually some degree of curvature on plan, according to the size and position of the battery. The outer ends of the roof-girders are carried by bars, which rest upon pillars one foot eight inches square, filled with concrete. The guns, as in the masonry casemates, are eight yards apart, as they cannot easily be worked at closer intervals. The outer basement wall, which carries the iron wall, is made fifteen feet thick. It is faced with granite; and to allow of facing it with iron, if necessary, bolt-holes are made through it, and a bolt-passage behind it. Inside, but covered by another wall about five feet thick, are the magazines and their passages. Special lamp-passages are provided, so that the magazines and their passages may be lighted without bringing any lamps into them."

It is not likely that any other country will build, or England herself ever again build, "iron-fronted batteries."

The Gruson shield is made of chilled cast-iron. The merits of this shield, both as to its form and material, will be discussed under the head of "Revolving Turrets." A general idea of its form, and the mode of applying it, may be gathered from Fig. 21.

The armored battery is adapted to all sites where great lateral range is not required. As a rule, however, its use should, for economical reasons, be restricted to low-lying sites, especially where ships can lay themselves close alongside of the battery. There is this to be considered, however, and that is, that the armored battery demands for the same number of guns almost as much space as the unarmored open battery; and hence, where artificial sites must be made, and space is costly, they must give way to the armored turret.

The Board of Engineers, U.S.A., in its report for 1881, says, "From the great advance made in the power of guns mounted on war-ships during the past twenty years, and in the resistance of their new armor to projectiles, — by which they are enabled, without great risk, to approach near enough to shore-batteries to give efficiency to their own fire, — it seems to be generally conceded that earth parapets and iron shields are the most suitable cover for shore-guns yet arrived at. The earth parapet commends itself by its comparative cheapness, and there are many positions in which it can be used effectively."

Revolving turrets afford an almost absolute security to the guns firing through minimum ports, and to the garrison. They have a great, and, if the configuration of the coast be favorable, a full, field of fire; their construction permits of rapidity of fire of the guns; and they can defy an enveloping attack, if the strength of the turret armor be sufficient.

For these reasons, the armaments of revolving turrets are much more effective than the same number of guns of equal caliber when mounted in another form of battery. The armament of a revolving turret for two guns is generally considered as equivalent to that of an open battery for six to eight guns. Some authors place a still higher estimate on their value.

It were almost a vain task to undertake to enter into a discussion of the merits of revolving turrets, since there are no instances recorded of their actual use in combats, and in that sense they must as yet be regarded as experimental. The rapidity of fire of their guns, although generally greater than that of the guns of an open battery, is, however, not twice as great. The guns of the open battery — that is, those on sites of high elevation — are not so very liable to be dismounted, that we may, for a short fight, regard the armament of the turret as twice as effective. Then, too, the conditions are often such that it is not sufficient to provide only for a *good protection*, but also for a *numerous armament*. Besides, turrets for heavy coast-guns are very costly: it is stated that their cost is sufficient to provide more than a second armament similar to their own.

Like the armored battery, the turret should be applied to sites at the sea-level, or but little above it. They are particularly adapted to artificial sites, to very advanced points, or small peninsulas which are exposed to an enveloping attack: they are also chiefly adapted to advanced positions next to the harbor-entrance, where they may not only act against the open sea, but may also flank the obstructions. They are particularly effective when the channel is such that the ships attempting to force the harbor-entrance are compelled to move on an arc everywhere equidistant from the turret, thus calling for no changes in the elevation of the guns, and increasing the probability of the turret-guns making effective hits.

The Board of Engineers, U.S.A., has recommended the application of the turret system to Boston and other harbors of leading commercial interest. In one of its reports the Board says, "The turrets would form a necessary adjunct to the barbette system, and no naval ship yet built or designed could remain under their close fire long enough to do them damage."

Again it says, "This Board is entirely in favor of using iron turrets for seacoast defence in the most important harbors of the United States."

The English text-book says, "Revolving turrets, if of adequate strength, are the best of all methods of protecting ordnance for coast-defence. They combine the security given by shields, with more than the lateral range afforded by the barbette system; and the ease with which they can be turned gives special facilities for fire at moving objects, or for averting the gun-ports from the enemy while the gun is being loaded. Unfortunately, the area of their armor-plating exceeds that of shields, about in proportion to their gain in lateral range; and their consequent costliness precludes their use otherwise than sparingly, and for the heaviest guns.

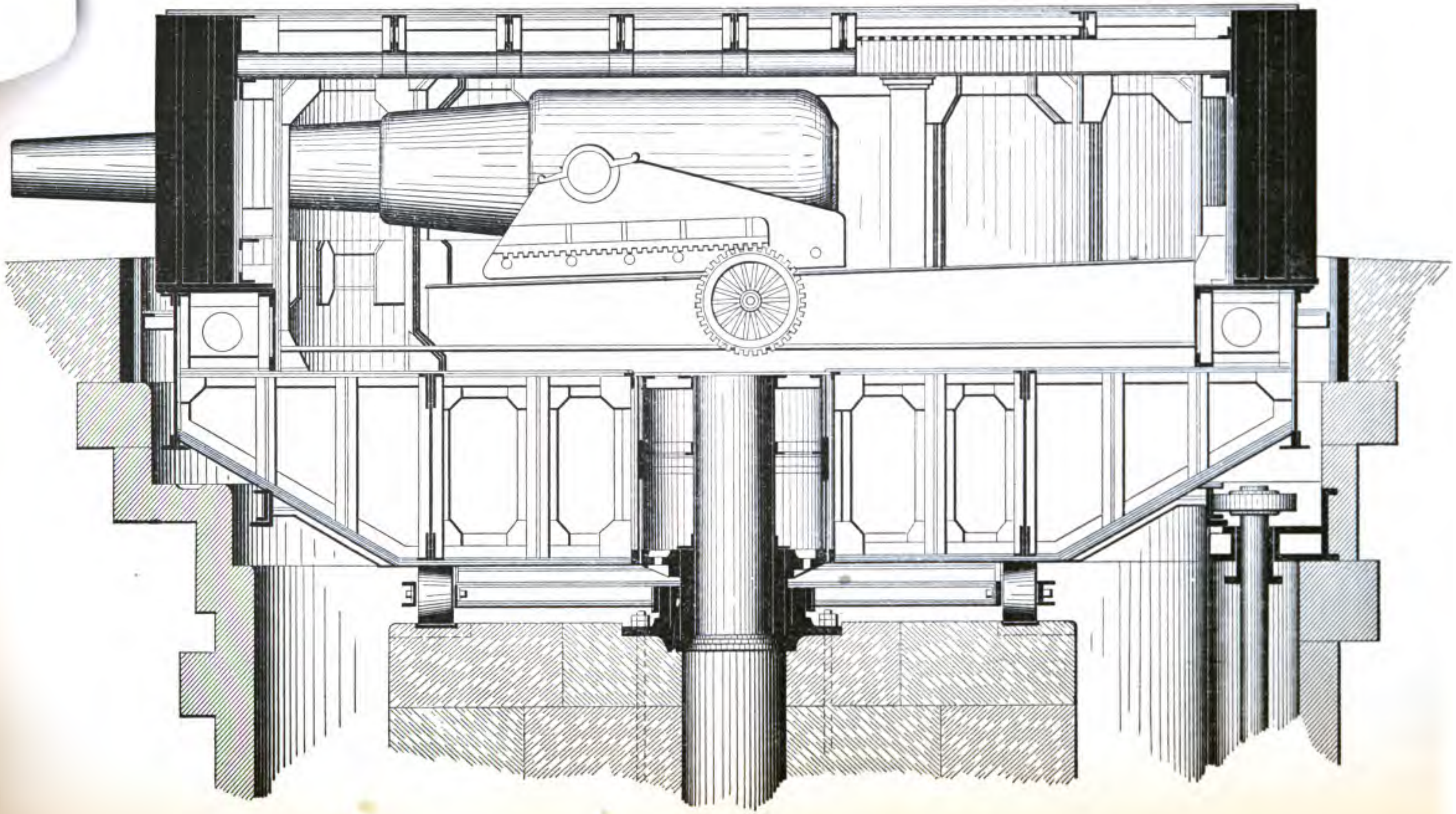
"It has been sometimes said that two guns mounted in a turret must be reckoned as equivalent to six or more guns firing behind shields with restricted lateral range; but, though this is quite true in relation to a ship moving uniformly on the circumference of a circle round the work, it does not hold good when a ship can be arrested by obstacles at a predetermined point, nor when there are likely to be several ships on different sides of the work at once."

There are two forms of turret, known as the "English" and the "Gruson." They will each be described.

A good idea of the Gruson turret may be gained from Fig. 22. It is made of a very tenacious and ductile quality of cast-iron, which is so cast as to chill the outer surface only for a moderate depth, there being no line of demarcation between the chill and the soft iron; the one shading off almost imperceptibly into the other: the grain throughout is fine and close. In order to cause deflection of the shot striking it, it is made ellipsoidal in form; and, by adopting this curved form, another great advantage is gained, in that the direction of the crystallization is such, that the body of the metal is put "in the best condition for resistance to impact," and gives "mutual support to the parts of a plate, even when the latter was fractured." The turret is cast in separate pieces, which, when put together, are mutually supporting. No bolt-fastenings are used, the different parts being bound together by means of zinc solder. The ports are reduced to a minimum, so that they fit the muzzle almost snugly. The gun-carriage is of such a form, that by the recoil the gun turns on its trunnions; and, even at the greatest elevation, the muzzle dodges, so to say, out of the port without touching it. The turrets have "aiming slots," or narrow cuts about two hundred and sixty millimètres in height and one hundred millimetres wide, provided with sights. As, by the aid of the slots, the pieces can be accurately aimed laterally by the turning of the turret, the carriages are not made to traverse. The turrets are so arranged that they may be turned both by engines and by hand.

Lieut. Very, U.S.N., says of these turrets, "The material and the manufacture are both comparatively cheap. Masonry is avoided almost entirely,—a condition that cannot obtain when wrought-iron plates are used for armor. Sections of the most complicated forms of double curvature can be cast without difficulty, whilst compound iron and steel plates must be limited in shape to single curvature. As weight is a matter of secondary importance in fortifications, the thickness of the blocks can be carried as high as desirable, without great embarrassment either to the designer or the manufacturer. . . . For a given expenditure of money a much more extended defence may be realized than with other systems of armor. That these advantages are beyond the region of speculation needs no better proof than the action of Germany, Russia, Holland, Italy, Austria, and Belgium, all of which nations are actively engaged in the construction of this type of defence for their frontiers."

Fig. 23



There is another great advantage in the use of this armor, and that is that it cannot be pierced, but must be *racked off*. Ships-of-war cannot well carry two distinct armaments; and, as most of them are armed with guns intended for piercing each other's side-armor, the Gruson turret will have the advantage on its side.

The English turret is shown in Fig. 23, which is a drawing of the Dover turret. Col. Inglis, R.E., says, "The work to carry this turret consists of an enlargement of the outer end of the pier as at present completed. The foundations are laid at a depth of about seven fathoms below low-water mark, and the guns will be at a level of about thirty-three feet above high water: the structure, therefore, from the bed of the sea to the guns, is about ninety-five feet high.

"Speaking in general terms, the turret consists, first, of a live ring, and rollers of steel running on a path of steel, laid on a massive cylinder of masonry. On this live ring runs a structure of iron framework of the form shown in the diagram, weighing about 240 tons. This framework contains the gun-chamber, which is protected by three thicknesses of seven-inch armor, with two intermediate thicknesses of two-inch plates, making together a weight of about 460 tons. If to these weights be added that of the guns, carriages, and the slides on which they will stand, the total running weight will be about 895 tons. This will throw upon each of the thirty-two rollers of the live ring a pressure due to about twenty-eight tons. The outside diameter of the turret is thirty-seven feet, its internal diameter is thirty-two feet; the interior height of the gun-chamber is eight feet eight inches; the height of the turret-armor is nine feet.

"It will be seen that a massive central casting is first held firmly down to the masonry, and that inside this there is a thick cylinder of hammered Bessemer steel, surrounding the built-up wrought-iron cylinder which forms the centre of the turret framework. I draw attention to this part, because, of course, the shock of blows on the turret-walls — or, more strictly speaking, the unabsorbed part of it — ultimately comes to this part; and it has received special consideration on that account. The framework is generally of wrought-iron.

"The roof of the turret is of strong splinter-proof construction. Over each gun there is a part of it which is removable, to admit of its being got in and out; and a part is made of open bars to allow a current of air to clear off any smoke that may enter the turret. The gun-ports admit of seven degrees of elevation and two degrees of depression. The turret is capable of all-round fire. The *glacis* outside the turret is supported by a ring of armor-plates on edge, five inches and three inches thick, on a strong circle of two-inch plating. The muzzles of the guns are brought inside the turret, and depressed to an angle of fourteen degrees for loading, which will be done under the *glacis* by steam-gear. But into the arrangements for that I shall not here enter.

"The turret is turned by a pinion, the vertical shaft shown working into a large ring, with steel trundles secured to the framework; the power being given by a set of main engines capable of working up to 300-horse power, and auxiliary engines of 45 or 50 horse power. For the working and loading of the guns, there will be another engine of about 30-horse power.

"All the engines and the boilers are in the lower part of the battery, some thirty feet below the guns. The magazines are at nearly the same level as the engines, and the shell-stores at a higher level.

"There will be a system of communication, by signal and speaking, from the gun-chamber to the engine-room, and throughout the battery."

Gen. Abbot, in referring to this turret, says, "The armor consists of three seven-inch plates, two two-inch plates, and six inches of wood: total, twenty-five inches of iron, and six inches of wood. The embrasures show the cross-section, there being no inner rings. The top is covered by about two inches of iron, which is arched over each gun a little, to give more space; and over the breech is a lattice-work. To point the guns, the officer looks through a simple hole in the top, through which he thrusts his head; but this will be modified by a plated protection. The *glacis* is of stone masonry, covered with two feet of concrete on top. It varies in thickness, from nine feet on the harbor-side to a minimum of twenty-three feet on the front.

"In my judgment, some radical changes will be necessary in this masonry *glacis* when the results of the recent Shoeburyness trials have been fully considered."

Speaking of the results of the trials of this turret, Gen. Abbot says, "Every thing worked satisfactorily, except in one respect: the recoil of the first gun caused the turret to revolve about ten inches, so that re-pointing was needful for the other. This difficulty it is proposed to meet by a brake."

The armament of this turret consists of two 80-ton guns.

CHAPTER V.

OBSTRUCTIONS AND SUBMARINE MINES.

In consequence of the great speed of war-ships (a quarter of a mile per minute), they may easily run past the batteries, and beyond the effective range of the guns, unless the channel be obstructed. This fact becomes all the more apparent if we consider the comparatively slow fire of the heavy coast-guns (about two to four minutes per shot). Consequently, only a few shots may be fired in a given time; while the rapid change of position of the target increases the difficulty of pointing, and renders hitting uncertain. If, however, the ship be stopped by obstructions in the channel, it not only remains a longer time within effective range of the coast-guns, but the latter have the advantage of firing at a stationary target.

From experiments made at Shoeburyness, it was concluded that the time occupied by a vessel in traversing one mile, at a speed of ten miles per hour, would admit of a 9-inch 12-ton gun being loaded and fired seven times, and the 22-ton gun three times, in each mile. Crossing the range of a 12-ton gun, mounted in a casemate or in a battery where the traversing angle is seventy degrees, at a distance of a thousand yards, at the speed of ten miles per hour, a vessel may be fired at six times: as the range is increased, or the speed diminished, a proportionately larger number of shots may be fired at her. *Cœteris paribus*, the 22-ton gun would have fired at her three times.

The obstructions should, above all, have a sufficient strength to resist the shock of the enemy's ships; and hence their character will be somewhat determined by the nature of the channel, or, in other words, by the character of the vessels which can navigate that channel. They should be able to withstand the influence of the elements, ebb and flood, currents, waves, prevailing winds, etc., and should not be susceptible of being easily destroyed by the enemy's fire. They should have such an extent that they close the whole of the navigable channel, and hence cannot be gone around. At the places selected for the passage of our own ships, they should be so arranged that they can be readily opened or removed, and then replaced. In consequence of the rapidity with which an enemy's fleet may appear off our coasts immediately after the proclamation of war, the obstructions should be susceptible of being quickly established. This requires that their construction should be of great simplicity. The material for their construction should be collected, and stored carefully at suitable points, in time of peace; so that, in the advent of war, no time may be lost. They should be so placed in the channel, that they may be flanked by a heavy fire of the most powerful guns; and they should be made secure against secret removal by guards on both shores, or by guard-ships.

There are two kinds of obstructions, *fixed* and *floating*.

Fixed obstructions are applicable only to those places which our own ships do not have to pass, whose depth of water is not great (less than twenty-five to thirty feet), and not subject to great fluctuations or changes of level; where the bottom is not rock or quicksand.

They consist usually of several rows of piles, one behind another; each row being composed of single piles driven at intervals, or in juxtaposition, or in groups. Rows of single piles in juxtaposition, held together by chains passed around them, and the intervals between the rows filled with stone, are used only in strong currents.

In the group system, the piles are driven in the form of a square, with the diagonal in the direction of the current, and are held together by chains fastened around them. The groups are usually disposed in chess-board order, in two rows; and the intervals are filled with rafts, which are fastened to the pile groups by chains. In some cases, the intervals between the groups of each row are filled with piles shod with iron points, and inclined to the front. In order to keep them in this inclined position, they rest on prop-piles in front, and are heavily loaded at the rear end with stones.

In such channels as are navigable only for small vessels, *chevaux de frise* of wood or iron may be used, instead of piles.

If it be a question of suddenly closing a channel, it may be done by sinking ships loaded with stone. In consequence of the costliness of this latter method, and the difficulty of raising the ships again in time of peace, it will be employed only as the last resort, when no other kind of obstruction is possible.

Floating obstructions are used in all cases where the advantageous use of fixed obstructions is impracticable, and also in great depths of water subject to great changes of level, in strong currents, and at those places which should remain practicable for the passage of our own vessels. Since, however, in order to offer a sufficient resistance, they must be anchored, they are inapplicable to places which have not good anchoring-ground.

They should be flexible, in order to give way to the current and the first contact of the enemy's ships: the advance of the latter should be retarded, and finally stopped, by a constantly increasing resistance.

This class of obstruction is formed of, —

Chains or *wire ropes* stretched across the channel, and supported by anchored buoys, rafts, or ships; *floating timber* (barricades), which, bound together in bundles by chains, support a strong chain or wire rope; *nets* or *cables* stretched across the channel in several successive rows, and supported by anchored buoys; to these are attached cable-ends, playing loose in the water, in which the screws of the ships or boats become entangled; *horizontal nets of cables or chains* which cover a large water-surface, and are also supported by logs, buoys, or rafts. The cable net is made of several strong cables stretched square across the channel, about sixty to seventy feet apart, and supported by large anchored buoys, which are connected by smaller ropes running obliquely to the main cables, and crossing each other, being supported at the points of intersection by smaller buoys. In the chain nets the chains run in several rows diagonally, and crossing each other between anchored logs or rafts, the longer side of which is perpendicular to the front of the line of obstructions. As the last class of floating obstructions, are to be mentioned the *linked rafts.* They consist of rafts twenty to twenty-five feet long, and four to five feet broad, which, formed of logs or timbers solidly bound together with iron bands and screw-bolts, are fastened to a ship's chain of the strongest kind, square across the channel, at distances of ten to twelve feet apart. They thus form, in a manner, the links of a chain of rafts. Each tenth or twelfth link is anchored. These chains of rafts are stretched in several rows, about twenty to twenty-five feet apart; and between the rafts of each two rows chains are stretched diagonally.

Submarine Mines.—Submarine mines are intended to serve as a submarine defence for harbor-entrances, mouths of rivers, channels, etc. They should be placed in such numbers, and in such an order, that hostile ships cannot pass them in safety, and that the explosion of one mine shall not injure its neighbors, or render them inoperative. The distances at which the individual mines are placed from one another depends, therefore, on the radii of their spheres of effect and upon their construction.

In general terms, they consist of strong envelopes, or shells, filled with an explosive substance. For this explosive, England uses gun-cotton. The explosive adopted by the United States is dynamite.

According to the method of firing them, submarine mines are, —

1. Mechanical contact mines;
2. Electrical observation mines;
3. Electrical contact mines.

The one great objection to any system of mechanical contact mines is, that they are dangerous alike to friend or foe when in position; and their planting or picking up is attended with danger. They constitute a very large and varied class. They are so arranged, that they explode on being struck by a passing vessel. Their firing arrangements are generally based on the chemical re-action of certain re-agents which are brought into contact by the blow on the mine. They may be exploded by the use of percussion fuzes. Several mines may be fired at once by means of a long bar, which the passing vessel forces down on the fuzes of a number of mines at a time. Of all the varieties, however, it is believed that the "Singer" falling-weight invention has been most extensively and successfully used. According to Lieut. Sleeman, R.N., this kind of mine has been so improved by Capt. McEvoy, that it may be moored with perfect safety: its action is certain, and it can be recovered with the minimum amount of risk. He says, "If the proper precautions be observed when carrying out the work of recovering self-acting fixed mines, — such as waiting for smooth and dead-low water, employing an experienced and careful boat's crew, and also using the submarine detector, — there should be no danger or difficulty whatever in picking up the 'McEvoy Improved Singer Self-acting Mine;' and this I aver with the experience I possess of such work with *unknown* self-acting mines."

The mechanical mines are easily and cheaply made, indeed, may be improvised at the last moment. They demand no conducting wire, no watching. They render the firing and observation stations of the electrical mines unnecessary, and are very dangerous to the enemy engaged in picking them up, or destroying them. On the other hand, as stated above, they are dangerous to plant: they close the channel to our own fleet as well as to that of the enemy; and they may be exploded by means of rafts let loose upon them by the enemy. As a rule, they should be used only in side channels, and only upon the score of economy.

Electrical observation mines are of two varieties; viz., —

(1) Ground mines, which are placed on the bottom of the channel; and (2) buoyant mines, which swim at certain fixed distances below the surface of the water, depending upon the manner in which they are anchored. As a rule, the ground mine is used in shallow water, and the buoyant mine in deep channels. The Board of Engineers, U.S.A., has provisionally recommended that ground mines, with a maximum charge of two hundred pounds of dynamite, be used in depths not exceeding forty feet at high water.

These mines are exploded from the shore by electricity at the moment a hostile ship arrives over a mine, or within its sphere of effect. In order to ascertain that moment, observation stations are necessary, from which the position of a ship may be accurately determined at any moment. These stations should be established where they may be secure from the enemy's fire, and at the same time have a good view of the channel. They are consequently ordinarily established on elevated points near the beach, and sheltered as much as possible from the view of the enemy. They are connected with the firing stations by telegraph; and the latter stations should be hidden, and made perfectly secure.

This class of mines is distinguished by great simplicity and safety of planting and picking up. The explosion of each mine is entirely under control; and it can therefore be made effective at will, and against any selected object which comes within its sphere of action. The mines can always be passed by our own ships in safety. Each observation mine, however, demands its own cable; and consequently the laying of the conducting wires is very costly. Night and fogs interfere with the observation, and render the use of the mines impossible or uncertain.

Lieut. Sleeman says, "Owing to the uncertain and complicated operations attendant on the work of exploding a ground fixed mine at the exact instant of the hostile ship being within its destructive area, I prefer to depend entirely on the buoyant system for the protection of harbors by submarine defence; and I consider it most unadvisable, and generally useless, to employ the ground system of fixed mines. . . . In the event of unforeseen circumstances rendering it impossible to use the system of buoyant mines, then I would rather trust to moral effect and self-acting mines than to go to the trouble and expense of laying down a system of ground mines necessitating the employment of any known method of observation firing, which at best can only be utilized at certain times."

The electrical contact mines have a general arrangement similar to that of the observation mines, but are distinguished from them in that the circuit is usually open, and is closed by a special apparatus, called the *circuit-closer*, contained in the mine itself, or moored above it as a buoy, upon being struck by a passing vessel. The circuit being closed, the firing battery is called into action. Or, instead of the mine being thus fired automatically, the circuit-closer may be made to send a signal to the shore, and the mine is then fired by judgment.

This latter class of mines is the most perfect, since their action can be so controlled that they may be dangerous only to hostile ships, and are independent of observation by sight. They unite in themselves most of the advantages of the other classes; but they are the most costly.

The objections to all electrical submarine mines are, that the conducting wires may be damaged or destroyed by the enemy, and they may be prematurely exploded by lightning, as in 1866, at Venice and Pola.

All submarine mines should be carefully guarded and defended by flanking guns. The Board of Engineers, U.S.A., in its report for 1874, says, "A device by which the tampering with a mine or its cable can be made to discharge a volley of guns previously pointed along the line has been perfected. Its value in the night or in fogs is apparent, especially as the explosion is effected without exploding the torpedo itself."

Each country has its own submarine-mine system, which is kept secret, and made known only to certain officers and enlisted men, who, on the advent of war, are to take charge of the submarine defence. It may be stated, however, that the mines will usually be arranged in several lines, in chess-board order, in front and rear of the obstructions, — somewhat in advance of and in rear of the batteries, but under the fire of the guns. By the chess-board order, the mines may be placed far enough apart to avoid sympathetic explosions, and yet leave no gaps through which a hostile vessel may pass in safety.

Since the War of the Rebellion (1861–65), the defence of coasts, harbors, etc., by means of submarine mines, has received great attention, and been closely studied; and today every nation having a seacoast to defend has a well-developed system.

In the Crimean War (1854–56), during a reconnaissance by the Allies before Cronstadt, the explosion of a submarine mine under the ships "Merlin" and "Firefly" caused so great an alarm to the squadron, that it put a stop to all further operations of the English admiral. It is asserted, also, that an attack on Venice in 1859, by the French fleet, was abandoned, because it was learned that the harbor was obstructed by submarine mines. During the War of the Rebellion, the Federal navy lost seven monitors and eleven wooden ships, not counting a number of transports, by Confederate submarine mines. In addition, many armored and wooden ships were for a time placed *hors de combat.* During the Franco-German War (1870–71), the French fleet carried a superb armament along the Prussian coast, without firing even one gun; and the reason given for such inactivity was, that the harbors were defended by submarine mines.

Dumb Mines, or Dummies. — The reason originally advanced for the employment of dummies was to increase the difficulty and tediousness incident to any attempt by the enemy to clear a space protected by submarine mines. For that reason only, should they be used. To depend upon such means alone, would be hazardous in the extreme. Still, a certain number of dummies may be used in almost all cases.

An important accessory to the use of submarine mines is the electric light, which should be used for illuminating any desired portion of the harbor, especially the mine and obstruction lines. It is not always effective, however. The Board of Engineers, U.S.A., in its report for 1875, says, "In clear, dark nights this light forms an important auxiliary in protecting the mines against boat-attacks; but in fogs, and also in bright moonlight, it appears to be of little utility."

Too much stress cannot be laid upon the fact that a submarine defence by mines is but auxiliary to that by the coast-batteries and their guns. The submarine mines wonderfully increase the efficiency of the guns; but it would be very dangerous to overestimate the value of the mines. It would appear, that in the past they have done good service; but it must be remembered, that, in every instance, the ships were unprepared to effectively encounter submarine mines. At the present time, it is true that a fleet cannot carry on an energetic attack in the presence of submarine mines, unless informed of their exact location, and provided with the means of rendering them harmless. The English text-book says, "It has been suggested that submarine mines may be attacked, like the counter-mines of a fortress, by means of large offensive mines; and it has been found by experiment, that a charge of four hundred and thirty-two pounds of gun-cotton, fired under a head of between forty and fifty feet of water, destroyed all mines within a radius of at least one hundred and twenty feet. The radius, however, will depend upon the strength of the mine cases; and, unless the position of the defensive mines is well known, this must be a tedious operation, and, under the fire of batteries, a dangerous one. If the attack is carried on by night, the defence may also be active then; and it has the great advantage over land defensive mining, that it is not forbidden to use large charges by the risk of giving cover to the enemy."

Submarine mines can in no case replace guns, especially as their own security depends upon guns. Guns and passive obstructions may constitute an effective defence, but submarine mines alone never. It must be distinctly borne in mind, that a submarine mine has but one life, and, having once been exploded in action, it cannot be replaced; while the activity of the guns is limited only by the supply of ammunition.

Submarine mines, more than any other weapon, call for experience, skill, training, and the closest attention, on the part of those operating them. From the very nature of things, they must be operated by "the few;" while guns can be fought by "the multitude," and without very great training. It is a well-established principle, that all engines-of-war should be as little complicated as possible, and as free as possible from delicate parts: therefore the main defence should never be left to submarine mines, which any one of a number of unforeseen accidents may render useless, and which can be operated by only a few men, whom it would be difficult to replace in time of action.

The very fact, that, once exploded, the mines are useless, should dismiss any idea of depending upon them alone for the defence of harbors. A brave and determined enemy will not hesitate to sacrifice a ship or two, if necessary, to open a gap in the mine-lines. Forlorn hopes are as old as war itself. Human life has always been held cheap, when, by its sacrifice, a great end was to be attained. It is not so long ago that the Light Brigade, without a murmur, knowingly marched to annihilation; and other men will always be found to walk into the jaws of death. Men will always be found who hold their lives but in trust for their country and its cause. So, then, we must well consider the fact that the enemy may open a passage through the mine-lines in some way or another.

CHAPTER VI.

ACCESSORY DEFENCES.

THE number and variety of accessory defences are limited only by the ingenuity of the people resorting to them. The only ones, however, which will here be referred to are torpedoes, torpedo-boats, submarine boats, and floating batteries.

Floating batteries will, as a rule, be resorted to only when the harbor is so open that defences must be established in the water, and the depth of the latter is so great as to preclude an idea of armored batteries on artificial sites. Col. Jervois, R.E., says, "There cannot be any object in substituting an unsteady platform — on which the amount of protection that can be afforded is limited by considerations inherent to floating structures, and which is liable to be taken away, or to be sunk — for a fixed and perfectly steady platform on shore, which can be fully protected, either against its fire being silenced, or from capture by the enemy."

It may be said, however, that, in the case of shoals in the harbor, floating batteries might be constructed in a manner similar to the hulls of modern war-ships; that is, with water-tight cells, which could be filled with water, sinking the battery to a steady bed. When no longer required, the water could be pumped out, and the battery, again become a floating one, towed back to its yard. Their great mobility might recommend their use where there is more than one channel to guard.

[illegible] invent[illegible] or are [illegible] now small [illegible] making a re- [illegible] is evidently [illegible] constant or peri- [illegible] which are accu-

[illegible] are fastened on the [illegible] from the bow of a small [illegible] the enemy's ship, and the [illegible] striking. They can be used only in [illegible] hardly to be conceived of in this age [illegible] precautionary measures on the part of [illegible] attacked. Only under the most favorable [illegible] possible to approach sufficiently [illegible] them under the shower of missiles [illegible] ship's guns.

[illegible] there are two

[illegible]

hundred yards of the enemy's ship, and then discharge the torpedo. The first-class Thorneycroft torpedo-boat carries three torpedoes; two being carried in transporting carriages on the sides of the boat, and the third in the torpedo-gun on the forward-deck. This gun can be elevated or depressed, and also trained so that the torpedo may be discharged ahead or on either side. The boats do not, therefore, have to attack bows on, nor is it necessary to stop them immediately before or after discharging the torpedoes; but they may run past the enemy, and discharge the torpedoes while at full speed. The torpedo is discharged by means of steam or compressed air. The boats are generally armed with machine-guns.

There are two varieties of the Whitehead torpedo, — one, fourteen feet long and fourteen inches in diameter; and the other, nineteen feet long and fifteen inches in diameter. The latter carries a charge of eighty pounds of gun-cotton, and is "capable of going a distance of one thousand yards at a speed of eighteen or nineteen knots." The former carries a charge of about sixty-five pounds of gun-cotton. The guaranteed accurate range is twenty-five hundred feet. The weight, including its charge, is about 670 pounds. The specific gravity is somewhat less than that of water, so that it floats.

The interior is divided into four compartments. The forward one contains the charge and the firing apparatus. The latter is so arranged, that the charge is fired by the torpedo striking a resisting solid. In order to avoid premature explosions, the mechanism is so arranged, that the firing apparatus is thrown into gear only after the torpedo has travelled a certain distance.

The second compartment, the secret of the invention, contains the horizontal steering apparatus, which keeps e torpedo, in its course through the water, at the depth which it is desired that it should do its work. The pedo, therefore, no matter how launched, always rises or s to the desired depth under water for which it is set.

The steering apparatus is connected with a rudder at the tail end of the torpedo.

The third compartment contains the motive power,—compressed air (sixty to seventy atmospheres).

In the fourth compartment is a small triple cylinder-engine, which, set in motion by the air issuing from the compartment in front of it, turns the screw propeller, at the tail end of the torpedo, with great velocity. In order to regulate this velocity, there is a so-called air-distributing apparatus. The velocity is determined by the distance to be travelled, or, better said, by the *range;* for the torpedo can be considered as nothing else than a submarine projectile. The shorter the range, the greater the velocity, and the reverse. For ranges up to about four hundred and forty yards, a velocity of twenty-four knots, for ranges up to about eight hundred yards, a velocity of sixteen to eighteen knots, is possible or permissible. It may travel a sea-mile; but its velocity under such circumstances is very small.

For coast-defence the torpedo is launched by the so-called coast-torpedo battery. This consists of a launching-tube, resting on stanchions driven in the water; and from this tube the torpedo, as soon as its engine is started, runs out without extraneous pressure, and solely through the action of its motor.

In the defence of coasts, the uncontrollable as well as the controllable torpedo will be used partly to support, partly to supply the place of, submarine mines, as well as for offensive demonstrations against the enemy's fleet, should it succeed in passing the obstructions and submarine mines. The Whitehead can be used only for short ranges, since at those only can it be at all relied upon to strike.

The merits of these torpedoes have been very much discussed, and there are very varying opinions as to their value for coast-defence. It is said that the French have at present between thirty and forty torpedo-boats at Cherbourg alone, and an admirable system of training, by means of which most of the seamen of the war-marine are instructed in the use of torpedoes and torpedo-boats. It is reported that the Italian admiralty attached great importance to the experiments made with torpedo-boats on the occasion of the naval review at Spezia, in 1883. When the "Dandolo" and the "Duilio" steamed out into the bay, and commenced firing, they were within a very short time enveloped in such a dense cloud of steam and smoke, that two torpedo-boats succeeded in approaching the ironclads, unperceived, to within two hundred metres. They were consequently at a distance at which they could discharge their torpedoes, although the manœuvre was executed in broad daylight. The experiments which took place at night gave still better results. All of the torpedo-boats were able to perform the task set them, and one of them approached the "Venezia" to within ten metres.

The difficulty of fighting the guns with precision, and of defending a ship against torpedoes and torpedo-boats, will be very great after an action has once commenced, by reason of the accumulation of smoke, and the time it takes to clear away. It is stated by eye-witnesses, that, as soon as the ships began firing at Alexandria, a bank of smoke arose like a wall, and prevented the results of the fire from being watched. Orders had to be given to cease firing until the smoke cleared away. Under such circumstances, swarms of torpedo-boats, each of which is armed with machine-guns, may prove to be very effective.

The Whitehead torpedo has one great advantage, and that is, that, if it strike at all, it strikes in a vital spot below the armor; and "the Oberon experiments have shown, that in spite of double bottoms, cellular compartments, coffer-dams, and other arrangements, a Whitehead striking fair, even with the reduced charge in the new pattern of thirty pounds of gun-cotton, would do great, if not fatal, injury to an enemy."

It is certain, however, that it cannot always be depended upon to follow the desired direction. Slight errors in adjustment of the parts, a slight bending of the rudder, a projecting screw, etc., may influence its path.

Capt. F. von Ehrenkrook says that the Whitehead torpedo, in its present shape, is not a weapon with which one may count on attaining good results at great distances.

Rear-Admiral Werner considers the small speed and the extraordinarily complicated adjustment of the working parts of the Whitehead as prominent defects, and is of the opinion that they can never be absolutely depended upon to take the desired direction.

Up to the present time, the Whitehead torpedo has been used for war purposes in three cases. The first time was in 1877, during the Chili-Peruvian war, against the "Huascar;" but she was not hit. The second and third times were in December, 1877, and January, 1878, against the Turkish squadron at Batoum. In the first of these cases, two torpedoes were launched against an armored ship at sixty metres' range, and both missed their aim. In the second case, two torpedo-boats attacked a Turkish steamer in the entrance to the harbor of Batoum. The torpedoes were launched at ranges of eighty and one hundred metres respectively. Only one of them struck the steamer, but, however, destroyed it.

Gen. Gillmore says, "The record of all the achievements of torpedo-boats and every form of offensive torpedo, during the Russo-Turkish war, shows, that, of the seven attacks delivered, six were conspicuous, and some of them disastrous, failures; and yet they were conducted with skill and bravery, and the launches used were, on the whole, of fairly good type. Some of them excelled in speed and in all the requisite appointments. On the other hand, the defence was not especially good in any case."

Of the controllable class there are two prominent types, — the Sims torpedo and the Lay torpedo.

Of the former, but little is known, except by the Board of Engineers, U.S.A. In the report of the Board for 1880, we find the statement, that experiments with an electrical fish torpedo, designed to be started by electricity from the shore, invented by W. S. Sims, gave results which showed the invention to possess merits of so high an order that one was ordered for trial. In 1881, again it reports, that "the experiments with the Sims electrical fish torpedo have shown the fact that the boat possesses merits of a high order, which will make it a useful adjunct to our submarine mines, and an efficient weapon for repelling counter-mining operations, and other attempts of the enemy to destroy channel obstructions." It again reports, in 1883, "During the past year, Mr. Sims has completed one, and is now making two more, torpedoes for the Government (omitting the motors for the present), each capable of carrying eleven thousand feet of cable and about three hundred pounds of dynamite. The speed thus far attained with the one-mile boat is about ten miles per hour, and when the motor is perfected a marked increase is expected. The invention supplies a useful auxiliary to our stationary mines, and should form a part of the material provided for the defence of our more important harbors."

The Lay torpedo was invented by Mr. John L. Lay, formerly an engineer in the United-States navy. It is of cylindrical form, with conical ends, and is made of plate-iron or steel.

The one exhibited at the Centennial Exposition is twenty-eight feet three inches in length, and is divided into four compartments by air-tight bulkheads. The forward end contains the dynamite.

The motive power is carbonic acid or ammoniacal gas, under a pressure of about forty atmospheres. The propelling engines, steering apparatus, etc., are placed in the rear compartment. It is provided with a double set of side wings, or horizontal rudders, by means of which its submergence (usually four-fifths of its volume) is regulated before launching. Two guide-rods — one in front, and the other in rear — project up from the torpedo, to indicate its position at any time of its journey. These rods are provided with hooded lights, for use at night, and can be raised or lowered at will by the operator. An electric cable containing several insulated wires is carried in the torpedo, and is paid out through a tube projecting to the rear under the torpedo, and beyond the propeller and rudder. By means of this cable, the torpedo is started, stopped, steered, fired, and its position ascertained at any moment.

The rudder is operated by a small engine; and it is made, by means of an electric current, to show its exact position on a dial on the keyboard in front of the operator.

The maximum speed claimed is ten and a half knots; but only seven knots were attained during the experiments at Newport. The charge may be fired either by contact with the object to be destroyed, or by closing the electric circuit.

The Russian Government purchased Lay's patent, and employed him to erect works in Russia for the manufacture of the torpedo; the necessary plant, machinery, and skilled labor having been imported from the United States.

CHAPTER VII.

ARMAMENT OF COAST-BATTERIES.

FROM the brief exposition already given of the operations which a fleet may undertake against coast-defences, it is to be seen that the coast-artillery, for the successful accomplishment of the task allotted to it, must be composed especially of guns, which, at the decisive combat ranges of one thousand yards and upwards, are capable of penetrating the armor of the strongest ships. Besides these, there are needed lighter guns for special work,— such, for example, as the prevention of landings, the repulse of boat-attacks, etc.; and, last but not least, heavy rifled mortars are necessary for vertical fire against the ships' decks.

In the experimental contest between guns and armor which has been carried on for a number of years past, the guns have so far kept the lead; and, as far as wrought-iron is concerned, the extreme limit of thickness of ship-armor has been reached, since regard must be had to the very important points of flotation, stability, and sailing qualities of the ships. Consequently, the latest efforts in the development of armor have tended to a reduction in weight, as well as an increase of resistance, and have led to the partial or entire substitution of steel for wrought-iron. It is the general opinion, that, in future, ships will be armored with compound or all-steel plates.

The compound plates consist of a hard steel face on a wrought-iron backing. At the Cammell foundery, the iron backing plate is placed in a furnace, and raised to a welding heat; and then, while still in the furnace, molten steel is poured on it to the requisite thickness. By this process, the steel and iron are joined by more than an ordinary weld; a portion of the iron, from one-eighth to three-sixteenths of an inch in depth, being converted into a mild steel. The plate is then removed from the furnace, and rolled, to insure thorough welding. The steel face is then tempered, and partially re-annealed.

In the Brown foundery, two plates are made, — one of iron, and the other of steel. Both are put into a furnace, and raised to a welding heat. The steel plate is laid over the iron one, but separated from it, and molten steel of medium softness run between them. The same welding action takes place as in the other process; and the whole plate is then rolled, tempered, and annealed, as in the case of the Cammell plates.

For the manufacture of the all-steel Schneider plates at Le Creuzot, France, the steel having been moulded into the required ingots, the latter are forged to shape under a 100-ton hammer. The finished plate is carefully annealed, then raised to a high tempering heat. The face is tempered in oil, and then partially re-annealed.

By this substitution of steel for iron, it will be seen that an attempt has been made to obtain increased resistance to penetration, by increase of hardness of the armor. With this increase of hardness, however, there has been introduced an increase of brittleness of the armor: in other words, while "keeping out" a shot, it may go to pieces under the impact.

The trial of compound and steel plates at Spezia, in November, 1882, with the 100-ton muzzle-loading Armstrong gun, resulted as follows: —

The first shot fired at the Cammell plate cracked it completely through: width of crack, from six-tenths of an inch to one inch. Several fine hair cracks were developed. The iron frame had yielded outwards from four to six inches, near the point of impact; and a number of bolt-heads in front were broken, and some cut by shot, fragments, etc. The whole plate was set back three inches at the end struck. In rear, one large plate-bolt was broken, and several small backing and frame bolts. The second shot did not penetrate the armor, *but broke it, bringing down the whole plate. All the bolts were drawn or snapped.* One beam in the rear was broken, others started and split. The plate was bulged at the back, opposite the point of impact.

The first shot which struck the Brown plate broke up, the indent being apparently but slight. The plate showed *a narrow long crack, and some hair cracks.* The plate had bodily moved back about two inches, and at right bottom, the corner struck, about four inches. At the rear, some small frame and backing bolts had snapped, but no large plate-bolts. The second shot *split the plate into six main fragments, all of which were dislodged, except one, which remained supported by two bolts.* The shot apparently had not penetrated to any great depth, but had broken the plate. The wood backing in the centre was split and torn: the side-frame pieces were thrown inwards at the bottom ends. At the back, two beams were badly broken and forced back, besides many bolts were dislodged. The plate-bolts were snapped or drawn, with the exception of the two which held up the piece of armor-plate.

The first shot at the Schneider plate produced no cracks. The iron frame was started, opening about five inches, near the point of impact. At the back, several small backing-bolts and bolt-heads were snapped off, but none of the large plate-bolts.

The second shot indented the plate eight and a quarter inches. The plate *split vertically across, and continued to crackle for many minutes, cracks forming and opening* until the main fissure was about nine-tenths of an inch wide near the bottom, and seven-tenths of an inch a little above the point of impact. Hair cracks were opened, apparently extending to a considerable depth; a very small one on the left edge visibly extending completely through the plate. The side frames were sprung wider open on the left. *From the shot-hole of first round, two new hair cracks were started by this round.*

The third shot struck the upper right-hand portion of the plate, breaking up that portion of the armor struck, and driving fragments of it into the backing and to the right. The right-hand frame was thrown aside, and left hanging by its bolts, nearly drawn. The top frame was thrown to the front, so as to hang over the face of the target. A part of the plate was brought down by the shot. The wood backing was rent and split, as seen from the front of the target. At the back, seven horizontal beams were broken and split; and some of the upper tiers of beams were lifted with the top frame. One large plate-bolt was driven far out. The entire portion of backing beams projected about four feet.

The fourth shot rendered the whole structure a wreck.

Not one of the four shots got through the target; but there was no longer an armor-defence.

The gradual increase in strength of armor led to the increase in power of guns; and to-day we have the two rivals, — the 100-ton Armstrong and the Krupp 40-centimetre guns. The development of guns has lately tended to an increase of power, not by increasing the already enormous calibers, but by increasing the length of the guns (35 calibers), whereby not only greater charges are employed, and greater velocities are attained, but longer projectiles (3.5 calibers) are used. The power of modern guns may be appreciated by referring to the following tables: —

TABLE I.

			15 cm.	24 cm.	28 cm.	21 cm.	28 cm.
			34.5	22	35	Iron.	Krupp.
			Calibers long.				
			Steel-bronze.	Krupp.			
			Coast Gun.			Breech-loading Mortar.	
	Weight of gun, including breech	kg.	6,029	15,500	37,300	4,872	10,198
	Weight of shot (shell)	"	50.3	132.5	255	87.2	216
	Powder-charge (maximum for mortars)	"	16	24	103	5.7	19
	Initial velocity of projectile	m.	506.8	433	605	233.5	307.8
Living force	total	m.t.	659.25	1,265	4,757.3	..	..
	per cm. circumference	"	14.15	17.1	54.08	..	..
	" " " at 500m	"	12.3	15.17	49.23	..	..
	" " " " 1,000m	"	10.7	13.43	44.82	..	..
	" " " " 1,500m	"	9.14	12.5	40.80	..	..
	" " " " 2,000m	"	7.97	10.52	37.14	..	..
	" " " " 2,500m	"	7.05	9.34	33.81	..	..
Penetration of armor	at muzzle	cm.	30.5	26.9	60	..	..
	" 500 metres range	"	27.5	25.3	56	..	..
	" 1,000 " "	"	25	23.8	52	..	..
	" 1,500 " "	"	22.5	21.5	48.5	..	..
	" 2,000 " "	"	20.5	20.1	45	..	..
	" 2,500 " "	"	?	17.8	42	..	..
	Weight of carriage including platform	kg.	6,775	9,586	23,000	..	9,220
	Maximum range with shell	m.	8,000	4,000	8,000	..	..
	" " " 60° elevation	"	..	..	..	4,000	?
	" " " 45° "	"	..	..	..	4,600	7,810

TABLE II.—VELOCITIES IN FEET PER SECOND.

GUNS.	Caliber.	WEIGHT OF		RANGES IN YARDS.															
		Powder.	Shot.																
	Inch.	Lbs.	Lbs.	At Muzzle.	600	1,200	1,800	2,400	3,000	3,600	4,200	4,800	5,400	6,000	6,600	7,200	7,800	8,400	9,000
100-ton Armstrong . .	17.75	550	2,022	1,715	1,653	1,592	1,535	1,479	1,424	1,372	1,323	1,276	1,232	1,191	1,156	1,123	1,093	1,066	1,040
100-ton Armstrong . .	17.75	776	2,000	1,832	1,765	1,699	1,637	1,577	1,518	1,462	1,408	1,355	1,305	1,259	..	..	..	..	..
81-ton Woolwich . . .	16	445	1,760	1,657	1,601	1,546	1,494	1,443	1,393	1,346	1,300	1,258	1,218	1,181	..	..	..	..	..
38-ton Woolwich . . .	12.5	200	800	1,590	1,518	1,449	1,383	1,322	1,266	1,213	1,166	1,125	1,089	1,058	..	..	..	..	..
71-ton (40-cm.) Krupp .	15.75	485	1,715	1,703	1,646	1,590	1,536	1,484	1,434	1,385	1,338	1,293	1,251	1,211	..	..	..	..	..
51-ton (35.5-cm.) Krupp	14	298	1,146	1,645	1,580	1,517	1,457	1,399	1,344	1,292	1,244	1,198	1,159	1,124	..	..	..	..	..
18-ton (24-cm.) Krupp .	9.45	165	474	1,688	1,614	1,544	1,477	1,412	1,351	1,294	1,241	1,192	1,149	1,113	..	..	..	..	..

TABLE III.—PENETRATIONS IN INCHES.

GUNS.	Caliber.	WEIGHT OF Powder.	WEIGHT OF Shot.	RANGES IN YARDS.															
	Inch.	Lbs.	Lbs.	At Muzzle.	600	1,200	1,800	2,400	3,000	3,600	4,200	4,800	5,400	6,000	6,600	7,200	7,800	8,400	9,000
100-ton Armstrong . .	17.75	550	2,022	27.68	26.70	25.73	24.82	23.93	23.16	22.23	21.45	20.70	20.00	19.34	18.78	18.26	17.78	17.35	16.93
100-ton Armstrong . .	17.75	776	2,000	29.38	28.32	27.28	26.30	25.35	24.42	23.54	22.68	21.84	21.05	20.32	..	..	..	..	..
81-ton Woolwich . . .	16	445	1,760	26.30	25.43	24.57	23.76	22.96	22.18	21.44	20.72	20.06	19.44	18.86	..	..	..	..	..
38-ton Woolwich . . .	12.5	200	800	19.36	18.49	17.67	16.88	16.14	15.47	14.84	14.27	13.78	13.34	13.03	..	..	..	..	..
71-ton (40-cm.) Krupp .	15.75	485	1,715	26.89	26.00	25.13	24.29	23.48	22.70	21.94	21.21	20.51	19.85	19.23	..	..	..	..	..
51-ton (35.5-cm.) Krupp	14	298	1,146	22.59	21.71	20.86	20.05	19.27	18.52	17.82	17.17	16.57	16.01	15.54	..	..	..	..	..
18-ton (24-cm.) Krupp .	9.45	165	474	18.21	17.43	16.68	15.97	15.28	14.63	14.02	13.46	12.94	12.48	12.09	..	..	..	..	..

Tables II. and III. are taken from Professional Papers No. 25 Corps of Engineers, U.S.A. The penetrations given are in wrought-iron, and were computed from what is called the "recent English formula:" —

$$\text{Penetration} = \sqrt[2.035]{\frac{V^2 P}{2g \times 2\pi r \times 2240 \times 0.86}},$$

in which

$V =$ velocity in feet per second,
$P =$ weight of shot, in pounds,
$r =$ radius of shot, in inches.

It is assumed that compound plates give a resistance to penetration about one-fourth greater than those of homogeneous iron.

Krupp's formula is, —

$$L = \frac{S}{10}\sqrt[3]{\frac{S}{2r}},$$

in which

$L =$ energy, in metre-tons per square centimetre of area, of projectile necessary to pierce the plate,
$S =$ thickness of plate, in centimetres,
$2r =$ caliber of shot, in centimetres.

The Gavres formulæ for wrought iron and wood backing are, —

For iron, $W = 1{,}600\, E \sqrt[0.7]{\frac{a}{p}},$

For wood, $U = 95\, e \sqrt{\frac{a}{p}},$

$$V^2 = W^2 + U^2,$$

in which

$W =$ velocity, in metres,
$E =$ thickness of plate, in decimetres,
$a =$ diameter of shot, in decimetres,
$p =$ weight of shot, in kilograms,

U = velocity, in metres,
e = thickness of wood, in decimetres.

The formulæ used by Gruson are, —

For port-plates, $d = 0.12\sqrt[4]{m.t.}$,
For side-plates, $d = 0.11\sqrt[4]{m.t.}$,
For glacis-plates, $d = 0.08\sqrt[4]{m.t.}$,

in which

d = thickness of armor, in metres,
$m.t.$ = living force of the shot, in metre-tons.

Capt. Orde Browne gives a very simple rule for penetration, which gives results agreeing very closely with those computed from the more complicated English formula. It is very easily remembered, and demands but little computation. It is, *The penetration of projectiles into wrought-iron is one caliber for every thousand feet of striking velocity.* For instance, let us take the 81-ton Woolwich, whose projectile at a range of twelve hundred yards has a striking velocity of 1,546 feet per second. The caliber is sixteen inches. By Capt. Browne's rule, we should have the penetration at twelve hundred yards as $1.546 \times 16 = 24.73$ inches. By referring to Table III. it will be seen that the "recent English formula" gives 24.57 inches as the penetration.

The question as to with what calibers the coast-batteries should be armed cannot well be otherwise answered than by replying, that they should be armed with the largest and most powerful calibers, especially since the batteries are less limited in the choice of calibers than the ships; and it is very important that they should have a superiority of guns at all times, and most especially for the decisive combats at the shorter ranges.

Of all the war-ships of the most important European navies, there are, —

37.5	per cent	with	a thickness	of armor of	4	to	4.7	inches
32.6	"	"	"	"	8	"	9.8	"
8.3	"	"	"	"	9.8	"	11.8	"
4.4	"	"	"	"	11.8	"	13.8	"
7.1	"	"	"	"	13.8	"	15.75	"
5.0	"	"	"	"	15.75	"	17.7	"
3.9	"	"	"	"	17.7	"	19.7	"
1.1	"	"	"	"	19.7	"	27.6	"

When we consider the great distances at which bombardments can be carried on by ships, and the thickness of their armor, it would seem to be a good rule that all batteries which can be approached by the heavily armored ships to within two thousand yards should be armed with the most powerful guns, such as the 100-ton Armstrong or the 40-centimetre 35-caliber Krupp guns.

Where shoals or channels of comparatively slight depth permit the approach of only the lighter armored vessels, or where armor penetration at great ranges is unnecessary, as in narrow entrances or side-channels, the smaller calibers, such as the 12-inch rifle, may be used; but even then it is to be remembered that the more powerful guns always guarantee a more effective result than the lighter guns. Gen. Gillmore says, "And, if his vessels also carry thick defensive armor, we are forced to use heavy projectiles against it, or our defence is worthless; for, where a large gun is needed to deliver a crushing blow, no possible accumulation of smaller guns will answer instead. Cumulative force implies unity of mass, and impact. A thousand pounds of grape-shot, even if fired as one volley, can be stopped by a 1-inch steel plate, but, if sent as a single bolt, it will shatter the best 12-inch armor."

The Board of Engineers, U.S.A., says, "Finally, these later experiments confirm this Board in its opinion, enunciated some years since, that while the 12-inch rifled gun may prove a sufficient armament for the barbette-batteries of our seacoast defences, as against the lighter ironclads of foreign navies, iron turrets, armed with guns of one hundred tons' weight at least, will be needed to meet the attack of armored ships of the latest construction."

There is this to be said, however, that in narrow channels, or at otherwise short ranges, the lighter guns may prove to be very effective. They may be mounted in great numbers, and produce good results through concentrated and salvo firing.

Again: the rapidity of fire of the lighter guns is greater than that of the larger ones; and, while volleys of grapeshot may produce no impression, the rapid and continuous or salvo fire of 12-inch, 11-inch, or even 9-inch guns, must be followed by good results. A molecular disturbance must be produced in any armor, and most especially in the more brittle kind which has lately been introduced. This disturbance must result in a breaking-up of the armor; and no ship will long remain in action with her armor hanging in fragments, if not entirely knocked off.

It will be remembered that the two 9-inch muzzle-loading rifled guns of Fort Marabout so annoyed the "Monarch," "Invincible," and "Penelope," having respectively ten, eight, and six inches of armor, that support had to be sent to them. Capt. Fremantle, R.N., says, "Heavy broadsides, even from numerous 9-inch and 10-inch guns, in these days of thick plating and partial protection, are probably more demoralizing and effective than the lesser number of shot from larger guns."

Commander Noel, in his essay on "Great Britain's Maritime Power," shows by an elaborate table, that thirty 12-ton guns might in ten minutes fire 50 tons' weight of shot, with a total energy of 696,600 foot-tons at 4,000 yards; twenty 18-ton guns in the same time throwing 30 tons' weight of shot, with a total energy of 454,750 foot-tons at the same range.

Nevertheless, too much stress cannot be laid on the fact that the coast-batteries should have a superiority over the ships; and that can be most safely and easily attained by arming them with the heaviest guns.

As for the kind of gun, it may safely be stated that the breech-loading rifled guns are preferable for all batteries, but most particularly for the open unarmored batteries, since they can be more rapidly and readily served, while at the same time there is a minimum exposure of the gunners.

For the repulse of landings, as well as torpedo and ordinary boats approaching the submarine mines and obstructions under cover of darkness, shrapnel, grape, canister, and even ordinary shell fire from the rifled guns of the older patterns, are sufficient. Machine guns may also be profitably employed.

The vertical fire of heavy mortars was formerly more dangerous for the wooden fleet than the horizontal fire of the heaviest coast-guns, since a single fortunate shot was sufficient to penetrate a ship from deck to keel, and sink it; while such a result could not be attained by even many gun-projectiles. In the bombardment of Sebastopol, on the 17th of October, 1854, by the allied fleet, it is said that the English ship "Albion" was hit ninety-three times in the hull, and yet could be taken to Constantinople for repairs.

A great many illustrations from military history, as well as the opinions of many eminent authorities, could be quoted to point out the great value of vertical fire from heavy coast-mortars in days past.

For example, Moering, in his "Dienst des K. K. Geniestabes im Felde" (1862), in referring to the measures to be taken against bombardments, says, "Heavy mortars in open batteries three hundred to five hundred feet above the sea, which can never be commanded by ships, protect sea-areas of five thousand fathoms' diameter."

Gen. Abbot says, "An attentive observation of this duel and of other firing at Petersburg fully convinced me that a mortar battery properly placed, properly constructed, and bravely served, cannot be silenced by any reasonable force, even on land. To imagine that a fleet can accomplish this is absurd."

Gen. Gillmore, in referring to Fort Wagner, says, "The armament of the work contained but two mortars (one 8-inch and one 10-inch). These, when earnestly served, caused the most serious delay in the progress of our work, and on one occasion suspended it entirely."

It can hardly be said, that, since the introduction of armored ships, too little attention has been paid to mortar-fire, since reflection shows that it must often be directed against ships which keep in motion, and that consequently its value is thereby much reduced.

If mortars are to be used against moving targets, they should be suitably mounted, and be supplied with mechanical arrangements for rapid service similar to those provided for coast-guns. If range-finders, and the other accessories necessary for firing at moving targets, be provided, then there can be but little difference between the fire of mortars and that of heavy guns.

The 28-centimetre breech-loading coast-mortar is mounted on a centre pivot platform. The elevation is obtained by means of a pointer on the right trunnion, and a quadrant on the corresponding cheek. In order to continually follow the ship to be fired at, a direct sight apparatus is placed on the platform.

Mortar projectiles require, of course, a somewhat longer time to reach the target than those of guns; still the times of flight are accurately given in the firing tables; and, as regards the precision of mortar-fire, only the errors made in the determination of the distance and speed of the ship are of importance, but really only in the same proportion as in the fire of guns. These errors, so important in the use of the old smooth-bore mortars, are more than compensated for by the increased accuracy of the rifled mortars. The fifty per cent deviation in range of the 30-centimetre smooth-bore coast-mortar at 3,500 metres amounts to 160 metres; that of the Krupp 28-centimetre breech-loading mortar at 3,550 metres, is 28 metres, or barely one-sixth of the deviation of the smooth-bore. At 7,800 metres' range, the fifty per cent deviation of the above-mentioned rifled mortar amounts to 54.28 metres, or one-third of that of the smooth-bore at mean ranges.

Yet, even if we attribute to the vertical fire of heavy rifled mortars no greater value than that of the smooth-bore of earlier date, that value is far from insignificant.

The decks of most armored ships are very weakly protected. In fact, the use of much stronger armor is hardly possible, on account of a resulting unfavorable change in the stability of the ship.

Of the present armored ships of the principal European navies, —

6 per cent have a deck-armor about 1 inch thick
12 " " " " " 1.5 to 2 inches thick
22 " " " " " 2.4 " 3.1 " "
1 " " " " " 3.5 " "

More than half (about 56 per cent) have no suitable deck-armor.

To-day, as formerly, the projectile which strikes the deck of a ship under a steep angle of fall, and with a sufficient force of impact, must be regarded by a fleet as the most dangerous.

Since mortar-fire is directed against the weakest part of an armored ship, the deck, and as the effect is only increased by an increase of range, while the penetrative force of the projectiles of even the heaviest guns is diminished by an increase of range, it would appear that vertical fire is the best means of protecting from a bombardment a harbor whose gun-batteries, in consequence of the configuration of the coast, cannot be sufficiently far advanced.

So great a value has plunging fire attained in the opinion of military men, that it is considered that one great advantage of high sites for gun-batteries is that the shot may have an angle of fall of eight degrees and over.

Capt. Browne says that the attack on the decks is the most destructive, and has the advantage that it can be made with guns which are not able to pierce the side-armor of ships; that elevated emplacements permit of such an attack, which becomes all the more effective, the greater the angle of depression of the guns. The platforms of the four 100-ton guns which are intended for Malta and Gibraltar are to be mounted about eighty-five feet above the sea-level. The ship which is struck on the deck by these shot will undoubtedly suffer terrible injuries. Ordinarily, however, we must rely on far weaker guns. The experimental firing at Shoeburyness (1870) showed that the 9-inch gun with a depression of eight degrees, and at a range of one hundred yards, cannot pierce an iron deck one inch thick; but shot from the same gun, with a depression of fifteen degrees, can destroy a deck-armor twice as strong.

It is evident that the use of such plunging fire from guns is possible only at short ranges, and hence cannot prevent a bombardment by a fleet. Capt. Barabino, therefore, urges the use of gun-fire under the greatest angles of elevation; or, in other words, he is in favor of using the guns as powerful mortars.

The "Journal des Sciences Militaires" says, "The decks of armored ships are at present the most vulnerable portions of them, and that fact lends a new value to the vertical fire of coast-batteries."

Admiral Robinson, R.N., says that the damage which would result to a ship from an accurate mortar-fire is certainly very great, makes the value of ship-armor doubtful; and a fight will show that only armored ships with strong deck-armor are safe.

Lieut. Hundt, of the German Marine Artillery, says that the mortar is especially dangerous for armored ships, since it threatens at the same time the deck, the screw, and the rudder; and that at great ranges the steep falling shot of guns produce but moderate results, while a single shell from a rifled mortar which strikes a ship may sink her. There is no danger to a fleet more imminent than the slow, methodical mortar-fire which endangers the decks and most vital organs of the ships, — the engines, boilers, powder-magazines.

Capt. Grivel says that mortar-batteries, which can be placed almost everywhere, are at the same time the best protection against bombardments.

Scheliha says that there is no armored ship which can stand the fire of heavy mortars.

Gen. Bylandt, as president of the Austrian "Militar-Comité," recommended that a coast-defence should always be based on mortar-fire.

The Board of Engineers, U.S.A., in its report for 1870, says, "To prevent the occupation as an anchorage of a roadstead, there is nothing more effectual than the mortar. It is well known that there are no projectiles of which sailors have greater dread than those from mortars, and that the invulnerability of the side of an armored vessel can be but very imperfectly extended to her deck. On the other hand, the difficulty of hitting by vertical fire an object of as small an area as the deck of a vessel is conceded. But when it is understood that considerable accuracy of mortar-fire can be attained against stationary objects (such as vessels in position), or arrested temporarily by obstructions at distances not exceeding the width of most ship-channels; and that the increased effect of successful shot will in some degree compensate for inferior accuracy as compared with the gun, — the mortar will readily be accepted as one of the most efficient means of defence against the modern means of attack."

Gen. Abbot says, "We want a projectile to plunge through a ship's deck and bottom, and sink her; or, if that is not possible, to perforate her deck, and endanger her magazines and machinery. A few large shells exploding in her hold, or even solid shot penetrating there from the deck, could hardly fail to place her *hors de combat*. . . . The most obvious advantage is, that the blow is delivered exactly upon that part which offers at the same time the least resistance and the largest surface: in other words, the mortar *assails the vessel in its most vulnerable part.* However much horizontal fire may be disregarded, no ironclad ever moved to encounter plunging shot without serious concern. If this be true of the fire of guns raised only eighty or one hundred feet above the water, how much more dreaded will be the blows given by projectiles descending at the high angles permitted in mortar practice! Moreover, high bluffs are not always to be found upon which to mount the guns required for the defence of important channels; but, by the aid of the mortar, a plunging fire is everywhere attainable."

Lieut. Very, U.S.N., says, "A new and most serious opponent of deck-armor is rapidly being developed in the rifled mortar, whose accuracy of fire up to a range of four thousand yards is sufficient to make it an extremely hazardous operation to attempt the bombardment of coast-fortifications while in a fixed position, — either at anchor, or stemming a current."

On account of the limited angle of depression at which guns can be fired, there must always exist dead spaces which can be covered by mortar-fire.

For the medium and short ranges at which ships must move with low speed, mortars will find a fruitful use, especially against bow-battery and turret ships, which manœuvre end on, and consequently present the most unfavorable target for guns.

Should it be able to accomplish nothing more, a heavy mortar-fire will always keep the ships in motion, or at least force them to changes of position, and hence reduce the accuracy of their fire.

The number of guns requisite for the armament of the individual batteries depends most especially on the disposition of the batteries, for which the most important principles have already been set forth.

There are only a few special points which remain to be considered.

The armament should be the more numerous, the greater the zones to be covered by the fire, the greater the number of hostile ships which may take part in the action, the more a deficiency in power of the guns may be supplied by an increase in number, and the shorter the time during which the ships must remain exposed to the fire of the batteries.

The Board of Engineers, U.S.A., in its report for 1878, says, "There is this to be said, that, if we become engaged in a war with a nation whose own ports are thoroughly defended, we must count on having his whole fleet make an attack on our ports, and consequently our defence must be organized with that point in view."

The Chief of Engineers, U.S.A., in his report for 1880, says, "It will be necessary for us to act, in the first instance, on the supposition that an assault will be made with his entire fleet; because, should we act otherwise, his coming in that array would involve both fleet and coast in inevitable defeat and ruin."

For the discussion of the probability of hits, we may assume the length of the larger armored ships to be generally 250 to 340 feet, and their width 50 to 67 feet; the height of the armor above the water-line to be about 13 to

26 feet; in the turret-ships the height of the crown of the turrets to be about 19 to 22 feet above the water-line; the diameter of the turrets to vary between 26 to 36 feet.

Upon the above assumptions, 100 per cent of hits may be counted on with the 24-centimetre Krupp gun, firing solid shot at broadside and battery ships at ranges of 1,800 to 2,400 yards, depending upon the size of the ship. The deviation of the 24-centimetre gun, firing at a target one metre high, at ranges of 1,000 and 2,000 metres, amounts to 35 and 15 metres respectively; and errors of range, ±70 to ±140 metres, will be compensated ± 30 to ± 60 metres by a height of target of 4 to 8 metres. Capt. Barabino, in referring to the same gun, says, "For direct fire at 9,000 metres, the rectangle containing 50 per cent of the shots is 11.2 metres broad and 85 metres long. At 6,000 metres, it is 5.5 metres broad and 70 metres long." In consequence of the flatter trajectories of the projectiles of the more recent guns, the accuracy is greater than that given above.

The trajectory of the percussion shell of the older 24-centimetre guns is not so flat as that of the solid shot, and hence the probability of hits is somewhat less. The shell of the 15-centimetre and 28-centimetre coast-guns, on the contrary, are fired with the same charges as for solid shot, and they therefore have greater velocities and flatter trajectories than the latter.

On an average, one may, on firing with the 24-centimetre gun at the sides of wooden ships, count upon 100 per cent of hits at 2,000 metres' range, and about 25 per cent at 3,000 metres' range. In firing at the decks, when the keels lie in the plane of fire, 100 per cent of hits with the same gun may be counted on at a range of 2,300 metres.

The motion of the ship affects the precision of fire of its guns, and we may conclude that the latter have the same accuracy as coast-guns of the same caliber and kind;

but the ship's guns have the disadvantage that the coast-battery offers a far more unfavorable target (ten feet in height) than the ship. Again: the sides of the ship often present a less resistance than was calculated upon, since the armor, in the course of time, through the rolling and pitching of the vessel in heavy seas, through the working of the engines, etc., becomes loosened from its backing, and the sides, therefore, become weakened. Shot striking on the joints between the plates, or on the bolts, may produce much greater results than looked for.

In action, an impact in a direction normal to the armor is, in consequence of the motion of the ship and the difficulty of estimating the range, generally the exception. An oblique direction is the rule, and the penetrative effect is diminished. If we represent by θ the angle which the direction of the impact makes with the normal at the point of impact, then, in computing the penetration, we must substitute for the striking velocity, V, the expression $V \cos \theta$.

The oblique shot, however, brings its whole living force into play; for, while one component is expended in penetration, the other produces on the plate struck a side thrust, which is transmitted to the adjoining plates, causing a straining and loosening of the bolts, which renders the racking-off of the armor more easy for succeeding shots.

Steel cylindro-conical projectiles fired against armor-plates commence to break up under an angle of impact of about thirty degrees, and chilled-iron projectiles under an angle of about twenty degrees. If the normal component of the velocity of an oblique shot exceed slightly the velocity necessary for perforation with a normal direction of impact, the projectile breaks up; but its fragments pierce the armor: the reverse being the case, it ricochets. Under an angle of impact of forty-five degrees, the projectile ricochets, producing only a slight abrasion on the armor-plate.

Those shots produce the greatest effect which explode after piercing the armor. Such effects are well described in the following words of the Italian minister of marine, Admiral St. Bon, in an address to the Chamber of Deputies, delivered Feb. 27, 1875:—

"You may picture to yourselves what effect one of these shots will produce on forcing its way into the battery-room (*ridotto centrale*), when, driving before it a litter of deadly fragments of wood and iron, it explodes there. The room is confined, the guns stand in two rows (right and left), the men are crowded together; every thing is mowed down, knocked down, destroyed; not a man remains erect, not a gun in condition to fire. From experiments on the "Guerriera" upon the depth of penetration of shell, we became convinced that the explosion of a single shell in the battery of a frigate would have produced the following results: sixty-nine men killed, and a gun dismounted."

In firing at ships' decks with coast-guns, an angle of fall of over nine degrees is necessary to attain satisfactory results. Solid shot produce less effect than shell, which explode, strongly shatter the deck, and break through it.

In Germany, in 1877, the long 21-centimetre and the 28-centimetre ring-guns were fired, at ranges of 3,500 and 4,500 metres, at a deck-target consisting of two layers of iron plates 25 and 59 millimetres thick, over oak plank 100 millimetres thick. The angle of fall for the 21-centimetre shot was thirteen degrees; for the 28-centimetre shot, about fourteen degrees. The 28-centimetre shells exploded on striking the deck, and shattered it. The chilled-iron solid shot of the same caliber produced but trifling effects, even for several hits close together.

At great ranges, at which sufficiently steep angles of fall (nine degrees and over) occur, the shell of coast-guns has an energy sufficient to seriously injure the decks of armored ships, and at shorter ranges the weaker side-armor, as, for instance, at the ends of the battery and casemate ships. This is the more worthy of notice, since, in the more recently constructed ships, the armor is confined more to the middle of the vessel, and the ends are therefore vulnerable: hence shell-fire should be directed against the weaker armor when the solid shot are not sufficiently effective against the strong battery or turret armor.

In firing with the 21-centimetre breech-loading mortar at a ship whose keel is normal to the plane of fire, 50 per cent of hits are attainable at 1,000 metres' range: with the keel in the plane of fire, 50 per cent and 100 per cent of hits are attainable at ranges of 3,000 and 1,000 metres respectively. The accuracy of the Krupp 28-centimetre breech-loading mortar is much greater. At a range of 7,800 metres, about 18 per cent of hits are attained when the keel of the ship is perpendicular to the plane of fire, and about 72 per cent when the keel lies in the plane of fire: at 3,500 metres' range, these percentages become respectively 34 and 98.

The effect of the 21-centimetre shell striking the deck of a ship was determined by experiments made by the German artillery in 1874. The target represented a portion of the deck of the "König Wilhelm," and was overlaid with a chain of 49 millimetres' thickness, the deck of the ship not being armored. At a range of 1,300 metres, it was cleanly pierced by using a charge of 1.5 kilograms, and elevations of 28½° and 58½°. It was concluded, from these experiments, that the 21-centimetre shell fired with a charge of 3 to 3.5 kilograms could pierce the decks of even the parapet ships of the first class.

Experiments at Cronstadt against an armored deck showed that the 24-centimetre steel shell pierced a thickness of 7.5 centimetres, and exploded after penetration. Such a result would cause so serious damage to a ship, that it would be compelled to retire from the fight.

Capt. Barabino gives the following: "In firing at a range of 5,000 metres, with the 14-centimetre cast-iron breech-loading rifle, at a vessel 100 metres long and 18 metres wide, with a charge of 18 kilograms and an elevation of 22.6°, the rectangle containing 50 per cent of hits will be 33 metres wide and 115 metres long; and, with a charge of 20 kilograms and 21.4° elevation, firing at 3,350 metres, the rectangle was reduced to 1.29 metres by 43.58 metres. From these data we have the following probabilities of striking with curved fire the vessel under consideration:—

DISTANCES OF THE VESSEL IN METRES.

	9,000	6,000	5,000	3,350
	per cent.	per cent.	per cent.	per cent.
Vessel with keel normal to plane of fire,	11.5	13.5	18	22
Vessel with keel in plane of fire	41	64	74	87.5

"The 28-centimetre Krupp howitzer in the experiments of March, 1879, firing with an elevation of 45°, at 7,800 metres' range, obtained 50 per cent of hits on a rectangle of 7 metres by 54.28 metres; firing under angles of 28°.36, at 6,800 metres, the rectangle was 2.6 metres by 44.7 metres; and firing under the angle of 30°, at 3,550 metres, the rectangle was 2.37 metres by 28 metres. Hence the vessel would probably be struck at the several ranges by the number of projectiles given in the following table:—

Distance in metres.	VESSEL WITH KEEL.	
	Normal to plane of fire.	In plane of fire.
	per cent.	per cent.
7,800	17.5	71.8
6,800	21	86.9
3,550	33.5	98

"We may admit that the probability of hitting with shell curved fire from the 24-centimetre rifle, up to nine thousand metres, will not be less than two or three per cent, if the target be the deck of a vessel moving with the speed of six miles per hour.

"These results, which at first view seem poor, do not seem so to me when we consider the condition in which a squadron is relative to a coast-battery while at such a distance away that it cannot harm it, and consider the immensely destructive effects that a successful shot from the shore may produce on the vessel struck. The experiments on the 'Guerriera,' mentioned by Admiral St. Bon, make it probable that two large projectiles which burst after penetrating an armored deck would be sufficient to make the vessel withdraw from action; and the withdrawal by one vessel of the squadron, and the incessant rain of heavy projectiles against the one or more still remaining, seem sufficient to demoralize the crews. As, in a battle on land, a tactical unit is considered disorganized when it has lost from one-third to one-fourth of its strength, so I believe that an attacking squadron would cease bombarding, if two or three of its vessels were forced to retire by the curved fire of seacoast artillery.

"But it may be objected, that the probability of hitting by curved fire is small, and that seacoast artillery will waste many shots in firing with full charges at great distances, or with reduced charges at large angles at smaller distances. It is impossible not to recognize, up to a certain point, the truth of the objections; but a sufficient answer is, that, in war, economical considerations lose value, and that hitting an enemy's vessel with curved fire is not so difficult that we should consider such fire simply a waste of ammunition."

CHAPTER VIII.

GENERAL MEASURES OF DEFENCE.

In view of the possibility of a sudden appearance of a hostile fleet, the preparations for the defence of the coast should in time of peace be so far carried out, that the proper instantaneous defensive arrangements may be made in the shortest possible time. Therefore the coast-batteries should be completely finished; the guns which are to be used on the sea-faces should be mounted, and ready for immediate use; and the material for obstructions, and most especially for submarine mines, should be on hand. All preparations should be made, so that the submarine mines may be quickly charged and planted. The observation and firing stations, galleries for the protection of the cables, electric-light stations, etc., should be completely prepared. These stations should be so placed that they may not easily be seen by the enemy, and still less be effectively bombarded; that is, they should be suitably covered or armored. They should generally be established outside of and apart from the batteries.

All of the land-batteries should be connected with one another, and with the interior of the country, by roads, or, better still, by railroads, as well as by electrical and optical telegraph.

The instantaneous defensive arrangements consist, on the one hand, of maritime measures; on the other, of such as are connected with a defence against an attack by land.

The first and most important measure is the immediate equipment of the entire fleet, then the charging and planting of the submarine mines, the establishment of the observation and firing apparatus, the placing of obstructions, and the equipment of the light-stations. Guards for the mine and obstruction lines are established, and suitable communication with the interior of the harbor and our own fleet organized by means of steamboats. The mine-stations are provided with depots of material, as well as workshops for repairing the same. The channel-marks, such as buoys, beacons, light-ships, etc., are removed, the lights extinguished, false lights burned at night, the pilots and seafaring population kept under strict surveillance; in short, all precautions taken to make the approach of the hostile fleet, especially at night, difficult.

The entire coast is divided into defence districts. Each district has assigned to it a detachment of coast-defenders; the number of ships composing each detachment depending upon the importance of the district, and the character of the work to be performed by the ships, — whether to simply serve as vedettes, or to supply an active defence. The main body of the fleet is concentrated in a well-protected position, suitable as a base of operations for offence, and usually in a war-harbor.

The preparations on land closely correspond to the maritime measures. The main body of the troops intended for the defence of each district takes station usually at a cross-roads or railroad junction; so that in case of landings it may be quickly moved to the menaced point. For a very extended coast, the main body is divided into sections, which constitute the reserves for the garrisons of the individual districts. The force in each district details a special reserve, garrisons the coast-batteries, and organizes for the whole district a guard and observation service. The guard-duty is performed by a chain of posts and outposts. At those points which are especially favorable for landing, strong detachments with field-guns are posted. Observatories are erected on high points, and observers familiar with maritime operations are selected to occupy them.

In the batteries the guns of the sea-faces are gotten ready for action, and in the land-fronts the usual arrangements of interior fortifications are made.

The most important duty in the defence against a blockade falls to the defensive fleet, to the coast-artillery, and to the offensive torpedoes.

The coast-artillery compels, especially by shell and mortar fire, the enemy's ships to remain beyond the maximum range, and thereby prevents even a temporary bombardment. The blockading fleet is annoyed and endangered by offensive torpedoes. If these torpedo-attacks be made with circumspection and boldness, they will produce excellent results. They will usually be made at night or dusk, when the small torpedo-boats may, unperceived, approach quite close to the enemy's ships, discharge their torpedoes, and then quickly run back. By day, if circumstances be favorable, fish torpedoes may be launched from the shore. In suitable currents, floating torpedoes may be used.

The defensive fleet, holding as long as possible suitable positions in the harbor under cover of the coast-guns, endeavors to maintain its own freedom of action, and, in connection with the coast-guns, to prevent a close blockade. It will act offensively with a few ships, in order to annoy the enemy, or to drive his individual ships from positions important to its own safety; with all disposable strength, in order to force the enemy to raise the blockade. In case of the retreat of our own fleet, the coast-guns keep the enemy from following, and prevent his entrance into the harbor.

The measures of defence against bombardments are: keeping possession of the roadsteads as long as possible by our own fleet; powerful fire from the coast-batteries, to prevent the approach of the hostile fleet; closing, if possible, by obstructions and submarine mines, the channel at such a distance as to keep the enemy beyond effective range of his guns; continued annoyance of the enemy by torpedo-attacks and small sallies of our own fleet; sallies in force by our own fleet. In the harbor itself, a strict police is organized, preparations against fires are made, valuable material and merchant-vessels are removed as far as possible, or placed beyond reach of the hostile fire.

The coast-guns fire at the greatest ranges, in order that, even if they cannot pierce the side-armor, they may menace the weaker deck-armor of the ships. The firing should not be limited to the most advanced batteries, but should be maintained also by the batteries in rear, which may be attained by the fire of the fleet. Rifled mortars should be extensively used.

The attack by sea should be opposed by an energetic fire of the coast guns and mortars, supported by the fire of our own fleet, by offensive operations of the latter, by preparatory measures against landings, by strict and strong guarding of the obstruction and mine lines, and by seasonable explosions of the submarine mines.

In order to obtain timely notice of any attempt to land on the part of the hostile fleet, and to be able to quickly oppose it, the outposts in the menaced district should keep a strict watch, and immediately inform the reserves of any and every suspicious movement of the enemy. As soon as the intention to land becomes clearly apparent, the special reserve hastens to the menaced point, and seeks to prevent the landing. It fires on the landing boats with field-guns, and, as soon as the boats arrive within range, it opens a rapid infantry fire, and charges with the bayonet the troops attempting to land. If the landing cannot be prevented, then the force fights, slowly retreating, and endeavors, by holding as long as possible suitable defensive positions, to stop or retard the advance of the enemy's troops on the coast-batteries. The garrisons of the batteries secure themselves against sudden attacks by keeping constantly and unceasingly on the alert.

The strictest watch on, and attention to, the movements of the enemy, are maintained by the coast-batteries erected for the protection of the obstruction and mine lines, by the guard-ships, and by the firing and observation stations. At night the mine and obstruction lines most particularly, are illuminated by the electric light. The guard-ships send out patrol-boats, which, if a favorable occasion offers, attack the approaching hostile boats, and drive them back.

It will depend mainly on the circumspection and resoluteness of the officers in charge of the observation and firing stations, whether the submarine mines perform their task of keeping back the enemy, or, at least, of inflicting on him a very serious loss in breaking through. Should the stations be destroyed by the fire of the enemy's guns, then a provisionary establishment of the apparatus must be attempted in the safest possible place. If the hostile fleet should attempt to break through the mine-lines with apparent chances of success, the *personnel* of the stations should, nevertheless, remain at their posts up to the last decisive moment, since a seasonably exploded mine may frustrate entirely the attempt to break through.

Should the hostile fleet succeed in forcing its way through the mine-lines, it must finally be fought with fish torpedoes, and by our own fleet; the latter using the ram as much as possible.

At ranges of over twenty-five hundred yards, especially at the great bombarding ranges of five thousand yards and upwards, all of the coast-guns which can be brought into action, and also the mortars, fire shells.

At short and medium ranges, at which it is possible to penetrate the side-armor of the ships, solid shot are used: the lighter calibers, which cannot pierce the stronger armor, fire shells against those portions of the ships less heavily armored.

The advance of a squadron or fleet to the attack of coast-fortifications will, if the channel be not obstructed, be ordinarily made in developed lines, since in that way all of the ships can come into action almost at the same time, and the fleet presents the most unfavorable target to the coast-batteries.

If the enemy open fire along the whole line, and at a great distance, then the fire should be returned with mortars, and the guns throwing shells. It is evident that the fire should be judiciously distributed among all of the ships, in order to keep them all under fire, and prevent any of them from carrying on the combat in a quiet, undisturbed manner, possibly even from rest.

Should the fleet or squadron advance in detachments, the most advanced one is to be subjected to the heaviest and most rapid fire. The activity of the fire should be increased so much the more as the fire of the ships' guns is the more effective. This increase of activity of fire should be so brought about, that, while more and more guns are brought into action, the fire of the individual guns should not, with reference to the ranges and the other conditions of the fight, be delivered hurriedly.

Should individual ships, through confidence in their strength of armor as well as the power of their guns, approach to within close range, then the gun-and-mortar fire is to be especially concentrated on them. This is important, also, for the decisive combat at short range. In order to attain a decisive result in the shortest time, a powerful, overwhelming fire should be directed against the most daring and dangerous ships.

Since elevated coast-batteries cannot be so effectively bombarded at short ranges as at great ones, the enemy will probably, at the time of the decisive combat, designate certain ships to keep up the bombardment at long ranges.

The fire of these ships need not be returned, or at least only by the distant batteries, since the batteries attacked should concern themselves with the repulse of the most dangerous enemy, and should utilize their high positions for delivering a plunging fire upon the decks.

Ships which have sustained serious injuries, or have lost their capacity for manœuvring, should, nevertheless, be subjected to an energetic fire. Should other ships go to their aid to take them in tow, then they should especially be brought under a heavy fire. Ships which retire from the fight, or seek shelter behind islands, and in side channels or neighboring inlets, should be followed by the fire of the guns, and constantly annoyed by the mortars, in order to render it difficult to repair damages, to extinguish fires, etc.

The lighter calibers should take part in the combat only so far as occasions offer themselves for advantageous work. According to the range, they fire shells or shrapnel, in order to sweep the decks, to rattle through the yards, to destroy the smoke-stacks, air-pipes, ventilators, etc., to menace the captain's bridge or conning-tower, as well as the wheel-house. Their attention should be particularly directed to ships which approach the places favorable for landings, and they should aid by their fire that of the troops and field-guns sent to prevent the landing.

The efficient conduct of the whole combat, on the part of the defence, demands very carefully considered preparations in reference to the ever possible changes of the method of attack by the enemy; and an efficient telegraphic communication should be maintained between all of the coast-batteries and the headquarters of the commanding officer of the defence.

The costliness of the ammunition of the heavy coast-guns, and of the latter themselves, demands finally a certain economy in the artillery-fire; that is to say, a well considered direction of its activity. Doubtless it would be well for the coast-artillery to be sparing of its fire at the great bombarding ranges, since the ships, in spite of their large dimensions, present only unfavorable targets, especially if they remain under way at moderately rapid speed. Yet this is by no means a cast-iron rule. As is known, it is a well-settled rule of defence against sieges by land, to repel, if possible, the commencement of the attack, and to be sparing only of those guns and munitions most necessary for the later stages of the defence. This principle should govern in the defence of important coast-fortifications all the more, since the defence falls almost exclusively upon the coast-artillery as soon as it is impossible for our own fleet to take part in any way in the combat.

Moreover, it will always be questionable whether the enemy will desire to pass from a bombardment to a real attack by sea at short ranges; and it would be very unwise, for the sake of economizing in ammunition, to do the enemy no harm, while he may lie off at long range, and inflict with his shells serious damage throughout the harbor and the city.

There is no doubt that a great deal of ammunition is required to attain any important results at the great bombarding ranges; and it is also unquestionable, that, for the prevention of a bombardment, not only a powerful, but also a very numerous, armament is necessary. The great point is to attain the development of a mass-effect, without thereby increasing the activity of the individual guns to such an extent that the accuracy of their fire is impaired or destroyed.

A suitable and efficient coast-defence is unquestionably costly; but throwing aside the fact that national honor and pride, and the respect of foreign nations, can have no money value, the question of cost reduces itself but to a question of insurance, which is as susceptible of calculation as simple interest on the loan of so many dollars. When we consider the wealth of our principal seacoast cities, we see that a very small interest on the amount of capital involved would provide and maintain a suitable defence against an attack by any possibly allied enemies. When we think of the loss and suffering which resulted from the Chicago and Boston fires, we must appreciate how much more terrible would be the consequence of a fire raging in New-York City, for example, with the larger portion of its population either driven from their homes, or demoralized, by hostile shells bursting in the streets, and fired by guns which cannot be silenced, and are safe from capture.

The great seaboard towns are the main sources of the nation's wealth, and their capture or destruction would cripple the whole country. In the "dull, piping times of peace" the interior towns do not appreciate the extent of their dependence upon the coast cities. Let, however, once the coast be laid under tribute to a foreign nation, and the interior will find paralysis has seized upon every branch of industry and occupation. Its pockets will be drained to *buy* off a foe which might have been *fought* off with the previous expenditure of one tithe of the amount of gold demanded. Preparation is more than half the battle: "the readiness is all."

CHAPTER IX.

EXAMPLE OF COAST-DEFENCE.

As an illustration of the modern principles of the defence of coasts, the following general description (with map) is given of the defensive arrangements of a portion of the German seacoast. While the description may not be entirely accurate, it is sufficiently so for the purposes of this work.

Wilhelmshaven. — The fortifications of this comparatively new but very important war-harbor, which were erected at an enormous cost, may be divided into three classes: —

1st, The batteries defending the port directly against the attack of a hostile fleet;

2d, The works serving as a defence against a land-attack;

3d, The batteries for the defence of the Jahde, which constitutes a narrow passage to the port.

The fortifications of the first class are, —

Fort Heppens with the permanent and provisional batteries adjacent, Battery Danensfeld, the Entrance Battery, the North Battery, the South Battery, and Battery Banter.

These works were commenced first, and are to-day entirely finished and armed.

The second class includes the extensive fortification of Mariensiel, Heiligengroden-Schaar, and Kniephausensiel-Rüstersiel, as well as dispositions for inundation.

As for the third class, the original plan was to establish two very heavily armored forts in front of the central part of the Jahde; but it was decided later on to substitute for them a fort on Wangeroog, and a certain number of floating batteries to protect the entrance to Jahde Bay.

In 1880 the preliminary work of the construction of a canal between Ems and the Jahde Bay, to connect Wilhelmshaven with West Friesland, and of a second canal between the frontiers of Prussia and the Duchy of Oldenburg and Lingehaven, were undertaken. The sum of about $2,025,000 was allotted for that purpose.

Mouth of the Weser. — The marine and commercial establishments of Bremen and its port, Bremerhaven, are very extensive and important. For their protection, powerful forts with revolving turrets have been established on the estuary of the Weser. Fort Brinkamahof, on the right bank, is an earthen barbette-battery with masonry walls, and a ditch at the gorge.

Farther seaward, and near the right edge of the channel, is another fort, called variously No. 3, Fort Brinkamahof No. 2, or Fort Weddewarden. It has four revolving turrets. Opposite to this fort, and on the edge of Langlütjensand, is Fort No. 2, with six revolving turrets. The distance between the forts is about twenty-eight hundred metres.

Fort No. 1 is situated on the edge of the flat named Langlütjensand, and about twenty-eight hundred metres to the rear of No. 2. It is an earthen barbette-battery, with an armored casemate-battery of nine guns under the parapet of the sea-face. The rear or inland face is of masonry.

These three forts are all built on artificial foundations, and at high tide are entirely surrounded by water.

Forts 2 and 3 constitute the first line; Forts 1 and Brinkamahof, the second line. Between the two lines is a bar, where the Germans placed obstructions during the war of 1870–71, and where it is intended to plant submarine mines.

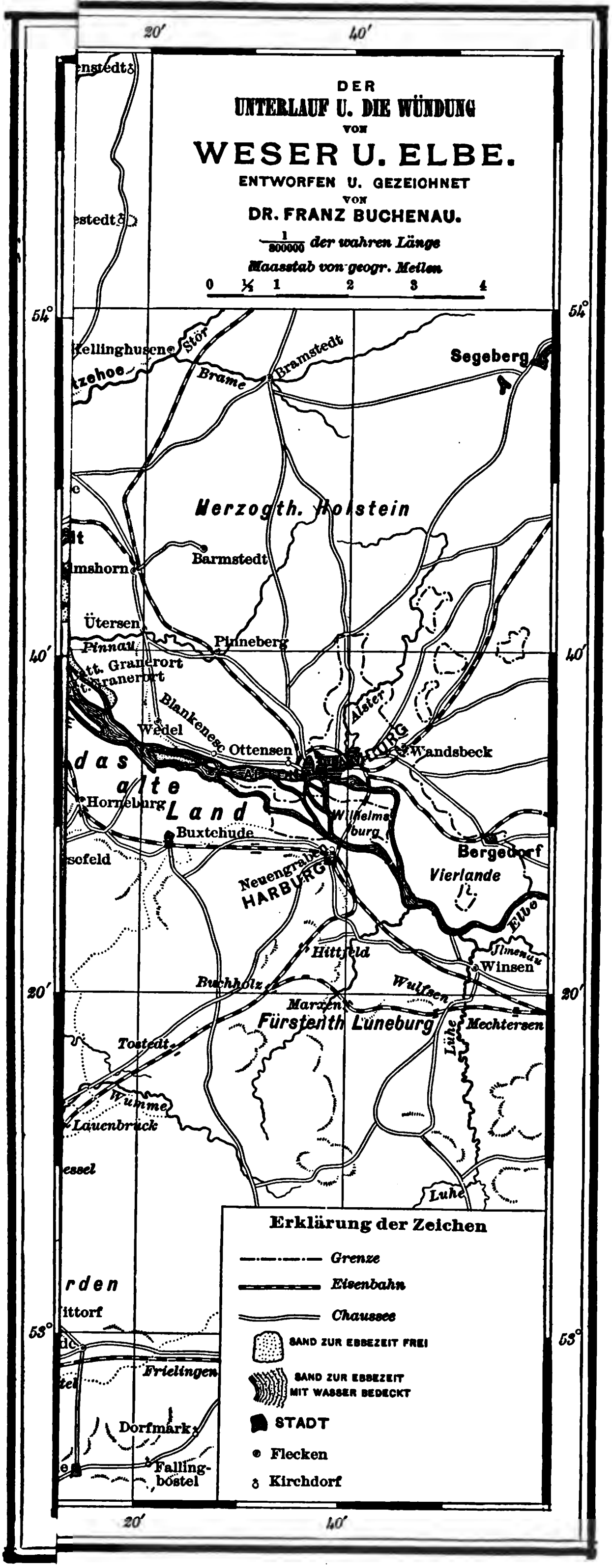
The turrets and casemates are the Gruson chilled cast-iron.

According to some authorities, each turret mounts two 28-centimetre guns side by side; but in the "Mittheilungen über Gegenstände des Artillerie- und Genie-Wesens" for 1883, it is stated that there are but three turrets which can accommodate two 28-centimetre guns each, and five which can accommodate one 28-centimetre gun each. The remaining two turrets each have two 15-centimetre guns.

Mouth of the Elbe. — In the neighborhood of Cuxhaven, at the mouth of the Elbe, the fortifications have been confined to the left bank, where the defence is very much favored by the fact that the channel lies near that bank.

At the extreme north end of the bank is situated Fort Kugelbaak, and in rear, and within sustaining distance of it, is Battery Grimmerhorn. The current opposite these works is so strong as to render it impossible to plant submarine mines in it; and consequently a more suitable place was selected above, and Batteries Oesterhorn and Grodenstack established to protect it. The Hamburger Battery is out of date, and very little importance is attached to it.

For the defence of the mouth proper, Fort Grauerort (1) and Battery Grauerort (2) were erected on the left bank, to the north of Stade, where the channel of the river is tortuous, and particularly difficult of navigation.



DER
UNTERLAUF U. DIE MÜNDUNG
VON
WESER U. ELBE.
ENTWORFEN U. GEZEICHNET
VON
DR. FRANZ BUCHENAU.

$\frac{1}{800000}$ *der wahren Länge*

Maasstab von geogr. Meilen

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